Official Transcript of Proceedings

NUCLEAR REGULATORY COMMISSION

Title:	Advisory Committee on Reactor Safeguards Fuels, Materials, and Structures Subcommittee
Docket Number:	(n/a)
Location:	teleconference
Date:	Wednesday, June 21, 2023

Work Order No.: NRC-2446 Pages 1-95

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ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

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UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

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ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

(ACRS)

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SUBCOMMITTEE ON FUELS MATERIALS AND STRUCTURES

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WEDNESDAY

JUNE 21, 2023

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The Subcommittee met via Teleconference, at 1:00 p.m. EDT, Ronald G. Ballinger, Chair, presiding.

COMMITTEE MEMBERS:

RONALD G. BALLINGER, Chair

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CHARLES H. BROWN, JR., Member

VESNA B. DIMITRIJEVIC, Member

GREGORY H. HALNON, Member

JOSE A. MARCH-LEUBA, Member

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MATTHEW W. SUNSERI, Member
THOMAS ROBERTS, Member

ACRS CONSULTANTS:
STEPHEN SCHULTZ
DENNIS BLEY

DESIGNATED FEDERAL OFFICIALS:
ZENA ABDULLAHI
LAWRENCE BURKHART

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P-R-O-C-E-E-D-I-N-G-S

1:00 p.m.

MEMBER BALLINGER: Okay. It's 1:00, I think. Yes, 1:00. The meeting will now come to order. This is a meeting of the Fuels, Materials, and Structures Subcommittee of the Advisory Committee on Reactor Safeguards.

I'm Ron Ballinger, Chairman of today's subcommittee meeting. ACRS members in attendance are Jose March-Leuba, Matt Sunseri, Vicki Bier, Joy Rempe, and I believe we will have online Greg Halnon -- I don't see Vesna.

MEMBER DIMITRIJEVIC: I'm here, Ron.

MEMBER BALLINGER: Oh, okay. Vesna Dimitrijevic. Anybody else? Oh, okay. Charlie Brown. And we have our consultants, Steve Schultz, present and Dennis Bley online. If I've missed anybody, my apologies.

Larry Burkhart is the Branch Technical Chief for the ACRS staff, and he's the designated official. Zena Abdullahi, who is virtually present, is the DFO, as well.

In today's meeting, the subcommittee will receive NRC staff safety evaluation for Southern Nuclear Operating Company's Vogtle Unit 1 and 2 amendment request and exemptions regarding the use of lead test assemblies of accident-tolerant fuel. The subcommittee will hear presentations by and hold discussions with the NRC staff and Southern Nuclear and other interested persons regarding this matter.

Part of the presentations of the applicant and the NRC staff may be closed, and I anticipate that that's true, to discuss information that is proprietary to the licensee and its contractors pursuant to 5 USC 552(b)(c)(4). Attendance at the meeting that deals with such information will be limited to the NRC staff and its consultants, Southern Nuclear, and those individuals and organizations who have entered into an appropriate confidentiality agreement with them. Consequently, when we go into closed session, we'll need to confirm that we have those conditions met.

The ACRS was established by the Atomic Energy Act and is governed by the Federal Advisory Committee Act. The ACRS is independent of the NRC staff. When applicable, the ACRS issues publicly-available letter reports and provides independent technical reviews of NRC staff safety evaluations of licensee's amendments to their operating licenses. As part of the review, we consider not only the staff safety evaluations but also the original submittal by the applicant.

ACRS members will ask questions and, at times, make statements. However, these statement are individual member opinions only, this is a subcommittee meeting, and should not be construed as ACRS findings or opinions. We only speak through our letter. ACRS opinions are documented in our letters.

We are now joined with Walt Kirchner, Member Kirchner.

The ACRS Section of the U.S. NRC public website provides our charter, bylaws, agendas, letter reports, and transcripts of all open-session subcommittee and full committee meetings, which include the slides presented. A transcript of this meeting is being kept and the open portion will be made available.

The meeting notice and agenda for this meeting are posted. We have not received any written statements or requests to make an oral statement from the public prior to this meeting.

Today's meeting is being held in person and over Microsoft Teams for ACRS staff members, staff, NRC staff, and the applicant. There is also a telephone bridge line. I'll remind people that, when addressing, you should state your name so that it can be transcribed properly.

So we'll proceed with the meeting. Let's see. We're going to call on -- who's first? Joe, are you going to make a statement first?

MR. MARKLEY: This is Mike Markley. Joe, are you online? Good.

MR. DONOGHUE: I am, I am. Yes. Good afternoon, Chairman and members. Thanks for giving him an opportunity to say a few words. My name is Joe Donoghue. I'm the Director of the Division of Safety Systems in the Office of Nuclear Reactor Regulation.

I just want to highlight that this amendment, this license amendment request and the exemptions you're hearing about today constitute a first-of-a-kind review for us. You know, it involves increased enrichment over five-person uranium and four lead test assemblies. You'll find that it's applicable only to the current burn-up limits that the staff has approved for Vogtle Units 1 and 2.

Staff expects that the future submittals that the industry has requested for higher enrichment and will address higher burn-up will be based on some of the information gained from these LTAs.

You'll hear about highlights from the

staff's safety evaluation. The staff determined that there's reasonable assurance that the health and safety of the public will not be endangered by allowing what's being proposed by the licensee.

These LTAs will be placed in limiting core locations without completion of representative testing for two cycles of operation, but that's considered acceptable by the staff.

Though a letter report is not required in this instance, we welcome any comments you might offer by letter.

And with that, I thank you for allowing us to present to you today. The staff will do its best to answer all your questions. And I turn it back over to you, Mr. Chairman. Thanks.

MEMBER BALLINGER: Thank you. I might add that these amendments are not only for increased enrichment but the LTAs are going to have chromium-doped fuel, as well as chromium-coated cladding. So it's a trifecta, If you will, and that's also a first.

So, Ryan Joyce, I don't know -- oh, okay. You'd like to make some opening comments, and you're also the presenter for Southern Nuclear, so you might as well just keep right on going.

MR. JOYCE: All right. Thank you. This

is Ryan Joyce. I'm the licensing manager for Southern Nuclear. I'd like to start off by thanking the ACRS staff for their review of this fairly important initiative. We believe this will provide valuable data for not just SNC but the entire nuclear industry as we move towards the advanced fuel features of accident-tolerant fuel, higher enrichments, and, ultimately, higher burn-up, ultimately allowing plants to ensure plants can stay economically viable and continue to provide safe, clean, and reliable energy.

Some benefits of this initiative will ultimately be increased safety margin, low electricity costs, longer fuel cycles, and reduced fuel assemblies for reload. So there's a lot of initiatives. We think this could do a lot of good for the industry, and, again, we appreciate the NRC's staff and ACRS's consideration and look forward to valuable discussion.

With that, I will go ahead and share my presentation.

MEMBER BALLINGER: I need to correct myself. Chromium doped has sort of turned into an acronym or a common term like Xerox. The fuel that you're proposing is not chromium-doped fuel, it's chromia plus alumina doped, so we need to be careful. I'm sorry.

MR. JOYCE: For the agenda, we'll go over the LTA program objectives and also talk about some key topics of interest that we believe will really demonstrate to the ACRS the amount of due diligence that went into preparing this amendment request and the analysis done to ultimately show that these LTAs will operate safely and within the analyzed core limits.

So for the goals of this program, there's basically two initial goals. We want to irradiate higher-enriched fuel rods up to six percent in a commercial reactor that ultimately will support future license applications. Although it's a very limited amount of rods for this application, ultimately, this will allow us to work through the commercial logistical licensing issues associated with loading higher than, greater than five-percent enriched fuel to allow, ultimately, more than five-percent weight assemblies to be loaded into reactor cores.

Additionally, we'll be gaining additional information on accident-tolerant and advanced fuel materials to help, ultimately, to batch loading of these, recognizing some of the benefits of these features.

So our LTA program will have four lead

test assemblies. Each lead test assembly will have four rods up to six-percent enrichment. All the rods will be AXIOM cladding, all but one rod will be coated with chromium. About half the rods, 136 per LTA, will be the doped ADOPT pellets. The other half will be undoped, 128 will be undoped IFBA pellets.

So the Vogtle core, there is 193 assemblies, 264 rods per assembly. So there's 50,952, almost 51,000, rods in the Vogtle reactor core. So of this 51,000 rods, 16 of these will have a higher than five-percent enrichment, so, again, a very small percentage of the overall core will have up to six-percent enriched fuel.

MEMBER REMPE: So in the open session, and you can defer to the closed session If you want to, but just for the public that might be listening in, could you talk a little bit about what in-pile and out-of-pile testing you've done to give you confidence in the ability of the cladding in an irradiated BWR environment, as well as what type of data you're hoping to get from the exams of the rods after this?

MR. JOYCE: Yes. We can discuss that. Jim Smith, who would be the best person to discuss that?

MR. SMITH: I'm going to defer to Radu for right now.

MR. POMIRLEANU: Hello. This is Radu Pomirleanu with Westinghouse. So for in-pile testing, we have had already a program which has irradiated chromium-coated cladding in the Byron Unit 2 reactor, and the same reactor also irradiated ADOPT, the doped pellets.

MEMBER REMPE: So the clad tubes were unfueled tubes, is that -- I get some of the different tests confused, but the way you've worded that, the coated rods did not have fuel in them; is that true?

MR. POMIRLEANU: Oh, no, they did.

MEMBER REMPE: Oh, okay. Good.

MR. POMIRLEANU: Yes, so they were fueled rods, yes.

MEMBER REMPE: Okay, good.

MR. POMIRLEANU: And for the AXIOM features, we had several lead test assembly programs in the past that have irradiated AXIOM for, I believe, it's at least three cycles. So we have quite experience with, you know, in-pile performance of these materials. Of course, for the doped and the chromium-coated cladding, the performance is still limiting at this point, but it's still more than two cycles. Well, it is two cycles.

MEMBER REMPE: Thank you.

MR. JOYCE: Any other questions on testing our or program objectives?

Next, I'd like to discuss specific topics of interest, again, to show the due diligence that was done in validating these assemblies will perform safely and within the analyzed limits.

So as I'm sure most of you, If not all of you, already know, the tech specs, technical specifications already contain provisions for lead test assemblies, one of these provisions as If they are placed in non-limiting core locations or regions. So we'll discuss why in a couple of slides, why we don't believe we could meet that non-limiting or why we believe we need to be in, quote, limiting core regions.

So as part of this, we're modifying Tech Spec 4.2.1 to allow these to be in limiting core regions, except for control rod ejection transients. We'll also explicitly allow the advanced coating cladding with doped or standard fuel material, and the Tech Spec 4.2.1 will allow a maximum of four rods per LTA with a nominal 235 enrichment of up to six percent.

In addition, the Tech Spec 3.7.18 fuel

assembly storage in the spent fuel pool and Tech Spec 4.3 storage will be changed to reflect the LTAs any spent, the spent and new fuel storage restrictions and the allowance for maximum nominal enrichment or four rods up to six percent.

I'd like to point out, so since we only have four rods per assembly with up to six percent, the overall, the weighted assembly enrichment is still below five percent. But the curves in the tech spec and the regulation generally just talk about an assembly enrichment of less than five percent. It doesn't really get into the rods of less than six percent. However, we felt it prudent to, A, part of this initiative is to make sure we exercise the regulatory process, go through everything that will be needed to load fuel above five-percent enrichment and then, out of prudency and to reduce any kind of regulatory uncertainty, we felt it was in our best interest to act as If these soon these assemblies will be greater than six percent, or greater than five percent I mean on an assembly basis. So all the exemptions, amendment requests, everything else, are based, while they specify only four rods, they're kind of the process we'd go through to ultimately load fuel beyond five-percent enrichment. Any questions?

So as part of this amendment and since this is modifying our licensing basis for the criticality accident requirements from a 10 CFR 70.24 exemption with an exemption for the monitors to instead adopt 50.68. We'll discuss the why in a couple of slides from now, but modifying our licensing basis from 70.24 to 50.68 resulted in modifications to the operating license to remove discussion of the 70.24 exemption we had in place. And this also necessitated that we then submit an exemption to 50.68(b)(7), which specifies an assembly enrichment must be less than five percent.

In addition, we requested an exemption from 10 CFR 50.46 and from Appendix K based on the use of AXIOM cladding. We'll discuss these exemptions further in the subsequent slides.

So 10 CFR 50.46 and 10 CFR 50 Appendix K do not explicitly cover the AXIOM fuel rod cladding material due to a slightly different composition than zircaloy or ZIRLO cladding material. Exemption requests will provide the application of 10 CFR 50.46 and 10 CFR 50 Appendix K regulations to the LT designs utilizing AXIOM cladding at Unit 2, Vogtle 2.

In conjunction with a 17-percent maximum (Audio interference) station acceptance criteria prescribed by 10 CFR 50.46, a more restricted embrittlement criteria was assessed, which is consistent with the data presented in the AXIOM cladding topical report.

So for regulatory clarity, SNC decided to adopt the newer 50.68 regulation to replace the older 70.24 regulation that was discussed in the facility operating license. Adopting 50.68 provides a clean, clear regulatory foundation for moving forward with higher-enriched fuel assemblies.

Our 50.68(b)(7) exemption, which is mentioned this is required in 50.68(b)(7) exemption to allow LTA rods with greater than five-percent enrichment, our technical justification, the intent of the rule is to preclude inadvertent criticality. We demonstrate through our analyses, as provided in this amendment, the intent of the rule is still maintained. NRC-approved shipping containers include their own criticality analysis. The adherence to this criticality analysis fulfills the 10 CFR 50.68 requirements pending placement of the new fuel storage racks. The remaining 50.68(b) criticality requirements aren't affected and will continue to be implemented, the new fuel storage vaults and for the spent fuel pool.

So the LTAs will have the highest linear heat generation rates at local peaking for parts of the cycle in those steady-state transient conditions. Nonetheless, the tech limits prescribed in the COLA and the cycle specifications will continue to be met for the LTAs and all co-resident fuel.

There are no additions needed to the COLA references listed in Tech Spec 5.6.5, and the analytical methods used to determine the cooperating limits will continue to be those previously reviewed and approved by the NRC.

CHAIR MARCH-LEUBA: May I interrupt for a minute?

MR. JOYCE: Yes.

CHAIR MARCH-LEUBA: Can you elaborate a little more on why we needed to put these LTAs on leading positions?

MR. JOYCE: I'm sorry. Say that --

CHAIR MARCH-LEUBA: Typically, we put LTAs in non-dominant positions. What was the rationale for not doing that?

MR. JOYCE: Well, I think, based on the enrichment themselves, these are going to be fairly -- so the 260 rods will be by less than five percent but they'll be close to five percent, higher --

CHAIR MARCH-LEUBA: And because the pin-to-pin peaking power in this particular LTA is --

MR. JOYCE: The fact that it will be six-percent enrichments means we'll have the 260 fuel rods in the assembly will be of higher enrichments, but then, of course, the --

CHAIR MARCH-LEUBA: So let me say it in my way. You didn't go out of your way to find the position in the core that will be limiting is because you place it in a position that would otherwise not be limiting, this pin-to-pin peaking factor caused you to be limited?

MR. JOYCE: So Westinghouse or nuclear fuel can correct me If I misspeak. The position would have been chosen based on the assembly enrichments to ensure that the peaking factors for the whole core are met as far as making sure that the power is fairly evenly distributed throughout the fresh assemblies. The fact that, again, If you have a 4.9 assembly, it's going to be at a higher power level just based on the fact that it's a feed and parts of the cycle -- and you're going to place it on definitely the ring of fire, the outside area, that's going to, again, lead to higher peaking.

So, yes, I don't think it was necessarily intentional. I think it was more a byproduct of the fact that it was --

CHAIR MARCH-LEUBA: That's not what I'm trying to rationalize. It's not that you were trying to obtain a higher flex to produce accelerating agent. It's just that, by place six-percent enriched uranium, it automatically brings itself up to those limits, right?

MEMBER BALLINGER: Do I read between the lines a little bit here in what you said earlier that the long-term plan is to do batch loads. And by putting the LTAs in what I would consider kind of a normal place, not in a limiting place, you're setting us up or setting the situation up so that when it comes time to do a batch, a full reload, you've got data that's not limiting. Is that what I'm reading in here?

MR. JOYCE: I would agree with that situation, I would agree with that assessment. The reality, when you're loading LTAs, you kind of do want them to be run harder than normally something would be to get really the data that you want. So I think that the benefit is the fact that, by placing limited assemblies, we will be get more relevant data to ensure batch loading that we're, we'll have greater confidence in batching loading.

CHAIR MARCH-LEUBA: Yes. But the other side, we place LTAs in your core because we don't have sufficient data to have enough confidence that it will be provided. So it's very daring, I mean, you putting them in there. I mean, just the leaking, you have problems. So you have to have a lot of confidence in what you're doing that it's okay.

MR. JOYCE: I believe, through all the analysis we've done that we have fairly reasonably high confidence that they will operate successfully.

CHAIR MARCH-LEUBA: Trust but verify. We have confidence that it works, but that's why we put LTAs to make sure.

MEMBER REMPE: So I guess I got the answer to my first, but what data will you be getting? You're just going to be looking to see what happens in the control room? Are you going to do some post-operation exams? Are you going to take the rods to a hot cell and cut them open? What kind of data are you going to get?

MR. JOYCE: Radu, can you speak to the validation we'll be getting and inspections we'll be doing?

MR. POMIRLEANU: Right now, the PIE plan

is not fully developed in support of future needs for the strategy to achieve high-enrichment higher burnups. We will be taking probably, you know, these rods to the hot cell. We don't know at this point, you know, the scope of that full examination. That full examination, the scope of that full examination is going to be determined by the needs of those future submittals. Right now, we're going to be, you know, looking at the rods as they progress through irradiation after each cycle, but the hot cell scope, it hasn't been defined yet.

DR. SCHULTZ: This is Steve Schultz. Is a three-batch irradiation planned for these assemblies?

MR. JOYCE: That would be the ultimate goal. However, right now, it's very unlikely we'd be able to irradiated more than two cycles without exceeding the license burn-up limit, so the end goal, a separate initiative outside the scope of this, would ultimately be come back in a couple of years to request going to higher burnups and then irradiate another cycle. But, again, that's future plans. That's outside the immediate scope of this request. Right now, we'd most likely limit it to two cycles.

DR. SCHULTZ: So that would be for the

six-percent enriched rods that are in the assemblies could, in three cycles, exceed the rod burn-up?

MR. JOYCE: Yes, by the third cycle. But, again --

DR. SCHULTZ: It could happen. It's not, I wouldn't expect it would happen.

MEMBER BALLINGER: In the third cycle, not the second.

MR. JOYCE: We would not exceed, exceeding the license per implement would require a separate, which most likely would happen in a third cycle, would require a separate amendment request and an NRC staff review.

MEMBER BALLINGER: But with respect to some of these exemptions, you're kind of, to use a more common term, you're kind of standing on the shoulders of giants. You've got data on all of the various fuel types already. The only thing you don't have is the greater than five-percent enrichment. So what do you suspect that the risk actually is for doing what you're doing?

MR. JOYCE: Like you said, we've already, or the nuclear industry, I should say, has already loaded AXIOM, ADOPT, chromium coating. The only thing that hasn't been loaded in the industry is greater than five percent. And as previously mentioned, we're talking 16 rods out of 51,000. So, again, a very small number, a very small number of rods.

MEMBER BALLINGER: At least two of those reports have an A at the end, which means they're approved by --

MR. JOYCE: Yes, AXIOM and ADOPT, yes. And it's worth it to point out, too, AXIOM and ADOPT have already been now reviewed by the ACRS. Again, we think the risk is very low, especially considering the small number of six-percent rods for this specific program application.

MEMBER BALLINGER: Continue to ask questions.

MR. JOYCE: Ask away.

MEMBER BALLINGER: Forge ahead.

MR. JOYCE: All right. The review of the LOCA evaluation models license proposal, which is bash for large break LOCA and no word for small break LOCA include the current models and correlations are acceptable to evaluate the LTA features in operation. Existing large break and small break LOCA analyses of record for Vogtle represent the LTAs, and the co-resident fuel is negligibly impacted by the presence of the LTAs. 10 CFR 50.46 acceptance criteria continue to be met.

For non-LOCA transients, there's two types of transients with regard to the core physics inputs: those that are dependent only on core-wide parameters and the other that are dependent also on local effects. The former category of events is not impacted by the LTAs based on the negligible impact on core heat transfer characteristics, decay heat, or initial core-stored energy.

The events that are dependent on local effects were evaluated for the potential effects to the LTAs. It was determined that there was no impact to codes or methods. Any impact in novel LTA features is offset by existing margins. While the LTA is mainly the core and peaking factors, they were placed in non-limiting locations with respect to raw ejection analysis. Ultimately, fuel-specific criteria applicable to each accident continues to be met.

MEMBER KIRCHNER: This is a public presentation. Unless you're well versed in the fuel cycle business, why don't you explain on the previous view graph what you mean about the rod ejection accident and where you place the lead test assemblies? In plain English, what does that mean?

MR. JOYCE: So the raw ejection accident

assumes you have a control rod in the assembly and that control rod, due to the pressure, it is ejected out of the assembly location, which leads to very high peaking. And this, of course, analyzed Chapter 15 accidents.

MEMBER KIRCHNER: So the LTAs are not going to go into control rod locations?

MR. JOYCE: Linda, can you speak to that?

MEMBER KIRCHNER: At six percent, you would expect --

MEMBER HALNON: Hey, Walt, we can't hear you.

MEMBER KIRCHNER: With six-percent enrichment in those four rods, If you put it in that location, that's where you would expect the highest impact for an rod action scenario; is that correct? So I'm assuming you're not putting them into control rod locations.

MR. JOYCE: Linda, these are --

MS. BAKER: Hi. This is Jennifer Baker, Nuclear Fuel. None of the LTAs will be in rodded locations, not for any of the cycles that they reside in.

MEMBER KIRCHNER: That's right. I just wanted you to get that on the record. Thank you.

Please, go on.

MR. JOYCE: The SNC evaluated the impact of radionuclide inventory on a per-assembly basis to compare the LTA inventory to a standard fuel assembly. The results of the ORIGEN-ARP analysis include there was inconsequential change on a per-assembly basis. Comparisons were made across a broad range, more broad than what's expected for operation, of variables include no consequential impact. Core-wide source terms representative of loading patterns with the LTAs were ORIGEN-ARP and compared to the core source terms used in the analysis of record for transients and fuel-handling accidents. The analysis of record source terms were bound for significant isotopes that contribute to dose. And as part of the reload cycle, as part of the reload process, reload analysis, source term inventories are confirmed every cycle on a per-cycle basis.

All fuel performance evaluations for the LTAs are performed with most recent set of NRC-approved performance models, which are PAD5. Although the current licensing basis for Vogtle 1 and 2 is PAD4, the most up-to-date models are used to evaluate the LTAs. The co-resident, i.e. non-LTAs, fuel continue to be evaluated with PAD4 with considerations of thermal conductivity degradation for LOCA.

When available, NRC-approved PAD5 models are used for LTA features. This includes PAD5 performance models for ADOPT fuel and AXIOM cladding. For chromium cladding, no model currently exists. Instead, the chromium-coated rods are conservatively modeled as though the chromium coating provides no corrosion benefits and evaluating the corrosion as If the chromium coating were extensions of base metal is conservative for fuel performance evaluations.

While it's not approved for enrichments greater than five percent, PAD5 fuel performance model was using test data up to 13 percent. Therefore, we feel PAD5 is an acceptable tool for evaluating the impact on enriched fuel.

MEMBER SUNSERI: Matt Sunseri. You might get to this later. Are there any -- excuse me. For the iron-enriched pins, are there any limitations on the ramp rates of the fuel or the fuel conditioning limitations that will change, you know, the operating practices?

MR. JOYCE: Jennifer, can you speak to that? Have we proposed any additional ramp rate restrictions?

MS. BAKER: We're not proposing additional ramp rate restrictions.

MR. JOYCE: For core physics, the LTA novel features will be modeled either explicitly or conservatively. There will be no changes to the approved methods for the reload analysis or for the neutronics modeling.

As previously mentioned, there's only a very few number of rods with enrichment exceeding five weight percent. While it's expected that these fuel rods will leave the core and peaking factors for portions of the cycle, their placement ensures that neutron spectrum is similar to the currently-operating cycles. Furthermore, prediction of the current codes is benchmarked to PARAGON2, which is approved for enrichments above five weight percent to ensure that peaking factor bias remains conservative.

There is no impact to the BEACON core monitoring system because the LTAs do not impact the ability to predict core response and the higher enrichment fuel rods will be placed away from the instrumentation tubes.

For thermal hydraulic designs, there are no modifications or updates required for any of the NRC-approved topical reports of thermal hydraulic methods for the introduction of the LTAs. The LTA departure from hydraulic performance is similar to that of the co-resident fuel. While the cladding coating may result in a reduction of flow area, any mixed core effects would be offset by available DNB margin in the reload design.

For the criticality analysis, the LAR addresses the increased enrichment, use of ADOPT pellets, and use of the chromium-coated AXIOM cladding with regard to the storage criticality. Modern codes were applied to address the LTA storage. For LTA storage not requiring burn-up credits, a direct reactivity analysis was performed. This analysis included the new fuel storage racks and the spent fuel pool two out of four checkerboard storage pattern.

For LTA storage required burn-up credits, a comparative reactivity analysis was performed. This included the all-cell checkerboard storage pattern.

DR. SCHULTZ: Ryan, on that slide, what is the intention of your statement modern codes were applied to separately addressed? Is it new codes that have not yet been reviewed and approved or --

MR. WENNER: No. This is Mike Wenner from Westinghouse. Essentially, previous versions of scale were used to do the analysis of record. However, we used the modern version of the same code on different hardware, so it's just the same scalable analysis. And then our current tools that we used for initial criticality were developing isotopics with the all-cell storage pattern is our PARAGON code, which we have had usage of for the past 10 or 15 years.

DR. SCHULTZ: Okay. So it's not, have not been applied to this particular evaluation at this particular spent fuel pool, but they are codes that have been applied elsewhere.

MR. WENNER: Correct, yes. So we were not using the old version of the same code. We're using the modern version and then a different lattice code to develop the --

DR. SCHULTZ: Thank you.

MEMBER BALLINGER: It's better to use the words updated, as opposed to modern.

CHAIR MARCH-LEUBA: And when you say everything is kept under quality control, it's the most up-to-date approved version of the code, correct? The microphone is very sensitive.

MR. WENNER: Yes, that's correct. SCALE Version 6.2.3, I believe, we used maybe 6.2.4; I'm not sure. But there's just a patch between the two.

CHAIR MARCH-LEUBA: Then all approved under quality control?

MR. WENNER: Yes, correct, yes. They're all installed as a validation associated with --

CHAIR MARCH-LEUBA: There have been cases in the past with other vendors I was involved with where they used the most recent version, but there's 25 versions behind the approved version. This is not that case.

MR. WENNER: Correct.

MEMBER KIRCHNER: So this is where a picture would have been useful. Where would the four pins be located in the fuel bundle?

MR. JOYCE: Jennifer, can you, do you have any picture you can show on the screen or describe?

MS. BAKER: I do not, but Radu may have one quickly available from past discussions.

MEMBER KIRCHNER: Are they adjacent to each other, or they're spread throughout the bundle?

MR. POMIRLEANU: This is Radu Pomirleanu from Westinghouse. The pins are not adjacent to each other.

MEMBER KIRCHNER: That's what I thought. All right. Thank you.

MEMBER BALLINGER: But we need to be sure that, If that information is not in a report that we have, that we get that information in for the record.

MR. JOYCE: The storage acceptability, the nuclear storage racks, and two out of four spent fuel pool patterns which do not require burn-up credits was determined via direct reactivity analysis. Any fuel storage rack in two out of four results demonstrates significant margins to the storage limits, including dry, fully flooded, and optimal moderation conditions to the new fuel storage racks. Those storage analyses credit IFBA, which will be verified during the reload process.

Additionally, multiple fuel pool misload event was evaluated with tech spec limit of 2,000 ppm and demonstrated acceptable results.

MEMBER HALNON: This is Greg Halnon. What does a direct reactivity analysis entail? What does that mean?

MR. WENNER: This is Mike from Westinghouse again, Mike Wenner from Westinghouse. It was just to make the distinction between what Ryan will talk about on the next slide in that we're looking at the reactivity specifically like we would for meeting the normal requirements. And then when he talked about the comparative reactivity analysis, we're comparing reactivity of 4.9.5 fuel assembly at its current limits to what the LTA looks like, so we're drawing some comparisons between the two and the change in reactivity from the LTA peak where, here in the nuclear storage racks in two out of four, we're looking directly at the reactivity.

MEMBER HALNON: Okay. I think I get it. Thanks.

MR. JOYCE: For all-cell storage, for spent fuel all-cell storage, the current burn-up limit with the maximum enriched fuel assembly is about 40 GWd per MTU. To provide significant conservatism to this limit, a burn-up limit of 64 GWd per MTU was selected for the LTA all-cell storage, which is, of course, greater than 24 GWd from the current burn-up limits or greater than eight percent effective margin.

CHAIR MARCH-LEUBA: What does AOR stand for?

MR. JOYCE: Analysis of record.

CHAIR MARCH-LEUBA: Thank you.

MR. JOYCE: Yes, there's acronyms in the back. So 64 GWd per MTU, the value was selected to apply additional storage options should the LTAs be approved for a third cycle of operations with burn-up greater than 64 GWd per MTU. So in other words, right now, under our current licensing basis, we do not have a way to load in the all-cell storage without requesting to increase the burn-up limit beyond the current license limit.

CHAIR MARCH-LEUBA: So explain this to me because, If you burn longer, your criticality concerns are less, so I don't understand this.

MR. JOYCE: Yes. So the all-cell will be the least restrictive requirements, so it's saying that, as you said, the longer you burn them, the less reactive they are. And so we have to burn to at least, for all-cell, the least restrictive loading requirements, we need to burn to at least, the tech specs would require us to burn to at least 64 GWd per MTU, after which --

CHAIR MARCH-LEUBA: But the limiting case would be you place in, you start up, and then you got a leak and you have to take them out and put them somewhere.

MR. JOYCE: Yes.

CHAIR MARCH-LEUBA: That would be a limiting criticality problem.

MR. JOYCE: Yes. So until it reaches that 64 GWd per MTU threshold, it will have to be stored in the all-cell two out of four spent fuel pool storage pattern.

CHAIR MARCH-LEUBA: Oh, you have a special area of the pool for highly reactive?

MR. JOYCE: Well, I don't know If I'd call it special area. It's just the loading patterns have to be more spaced out. There have to be more empty cells between fuel cells.

CHAIR MARCH-LEUBA: A special loading pattern for highly reactive.

MR. JOYCE: Yes, yes, those that do not --

CHAIR MARCH-LEUBA: So you plan to burn this to 64?

MR. JOYCE: That would be, that's a separate initiative, a separate LAR, but that would be --

CHAIR MARCH-LEUBA: The third cycle?

MR. JOYCE: Yes, that will be the third cycle. And, again, one of the ultimate goals of this program, you know, it's kind of a two-part program. The first is get approved to load the LTAs in likely two cycles, likely two cycles of operation. And then, during the meantime, the next couple of years, develop a license amendment request justification further, let some of the topical reports, the understanding of higher burn-up become kind of further along the, let some of the research become a little further along and, then in a couple of years, submit a LAR for a third cycle.

CHAIR MARCH-LEUBA: Understood. The concern I have is with people like Mike that have to calculate the core, you have to take those bundles in year one, year two, or year three. You cannot take it at year two and a half. You can always make it less than 64, but your time to hit 64 is going to be hot --

MR. JOYCE: Yes. So until reality, until about third cycle of operation, it will just be, again, it will be loaded in the two out of four spent fuel pool pattern.

MEMBER BALLINGER: So once again, you're playing the long game.

MR. JOYCE: This is a long game, yes. But, you know, again, that is the long game, and we ultimately do intend, we'd like to submit and ultimately like to seek approval to load beyond the current license limit and be able to take advantage of this work that Mike and others from Westinghouse have done.

CHAIR MARCH-LEUBA: Are you going to ask the question, or should I? If you load a fuel core with six percent, you won't be able to just reload one-third of the core every time. You're going to have to increase your batch size or decrease your batch size? The economics want to be there for a high-enriched core. I mean, I know you're going to have or at least should for longer burn-up, and that guides you to a 50-percent core reload.

MR. JOYCE: So right now, out of 193 assemblies, we might load, typically it was between 89 and 92 feeds per cycle. Going to higher enrichments and higher burnups would allow one of two things: less feed assemblies, maybe instead of 89, maybe we load 81 for example, or something else, another potential option would be going from, instead of one-and-a-half year cycles to two-year cycles. Again, those would likely necessitate increase burn-up along the way. Both would offer significant advantage, offer their own advantages to --

CHAIR MARCH-LEUBA: But you are the customer. You are the one paying for this. So you see a benefit?

MR. JOYCE: We see benefit in both. In reduced batch sizes, less spent fuel pool storage, less into dry casks. And, of course, we see benefits in two-year fuel cycles, too: less maintenance outages, less dose to the workers, et cetera.

CHAIR MARCH-LEUBA: And is this a difficult optimization problem. Different people can come up with different solutions, but you're the one paying for it and you see a strategy, a scenario in which these will be beneficial?

MR. JOYCE: Yes. We have our smart folks over in nuclear fuel that are working to --

CHAIR MARCH-LEUBA: And, typically, the smartest guys in the plant are the ones who do the reload calculations.

MR. JOYCE: Yes. They'll figure out what's best for us, for Southern Nuclear.

All right. That concludes my presentation. Are there any other questions or any other --

MEMBER KIRCHNER: What do you see as the major challenges going forward? So let's assume the lead test assemblies, this program is successful. Then the next step, obviously, is looking at higher enrichment for the whole bundle, what are the big challenges that you see down the road in doing that?

MR. JOYCE: Mike, you want to give them a high-level discussion of some of the challenges, you know, some of the issues we've --

CHAIR MARCH-LEUBA: If you position yourself right under the green light, speak loud.

MR. BOONE: This is Michael Boone from

Westinghouse. In terms of down the road, the challenges that are there are just getting that regulatory certainty on loading batches of high-enriched fuel, addressing problems such as FFRD, making sure that the plants will operate safely. It's just getting that regulatory certainty about what will be the requirements for the industry moving forward.

MEMBER KIRCHNER: But what are the major limits that you see? Is it rod ejection, or is it your power peaking, or is it burn-up? What are the technical challenges, not just the regulatory challenges?

MR. BOONE: I would say --

MEMBER KIRCHNER: Safety concerns is a better way for me to say it.

MR. BOONE: I would say, from my perspective, my limited perspective, others can differ, is just the burn-up and the challenges that we may have there.

MEMBER KIRCHNER: So would that, like in the reg guide for rod ejection, you would be looking for more data there to extend the burn-up limits?

MR. BOONE: I would have to ask some of my technical experts to kind of weigh in on that. I probably don't have the background to weigh in on that specific question.

MR. JOYCE: And I think, for rod ejection, when you do a batch loading, If you have 89 assemblies, you don't load 89 assemblies enrichments. You might, you know, a typical loading pattern might have, we'll say 40 assemblies that are 4.2 enrichment, 24 to 4.2 and the remainder at 4.6 or 4.8 or something like that. So we could always, you know, most likely, we might be looking at, you know, If we go down to, we'll say 81 feeds per reload, we might have 20 of those be above five-percent enrichment. The majority would still be most likely less than five-percent enrichment, depending on the fuel cycle length and anything else.

So I think our core designers could work around and make sure that they, for as far as -- we'll not be required that under rod locations they could put either heavily poisoned, you know, IFBA, WABA, or some other kind of advanced poison, heavily-poisoned rods, lower-enriched rods, there's different options they can do to make sure they meet the analyses.

MEMBER BALLINGER: Back to the burn-up issue, is the technical long pole, the tent, If you will, how much of it is technical and how much of it is regulatory? What I'm trying to get at is there's this looming FFRD issue that is part of, at least in theory, part of the increased enrichment pool, and the industry is working hard to deal with that now.

So is that the issue? Is it regulatory with respect to FFRD, or is it a real technical problem, or some other thing?

MR. BOONE: I'm going to be careful how I answer that. I think it depends on perspective. The industry needs to have the data to show that it's not a technical concern, and that's what we're working to.

MR. JOYCE: So the higher burn-up is one of our end goals, but, for the scope of this request, though, we intentionally kept it separate to --

MEMBER BALLINGER: But you're in the long game.

MR. JOYCE: Very true.

DR. SCHULTZ: It's the purpose of the LTAs. Fairly higher enrichment must bring with it higher burn-up If you're going to get a benefit. Otherwise, it just costs more.

MR. JOYCE: That's correct. I would agree with that statement.

CHAIR MARCH-LEUBA: And I'm talking short game. Are you concerned about transition cores? When you load your first third into the core and a fresh 81 bundles with high enrichment, are they being warped too much or are you going to use permeable poisons or -- I mean, it's a problem --

MR. JOYCE: Yes. So like I mentioned, they have, there's different options that can be used to flatten the core peaking, different permeable poisons. Right now, we primarily use IFBA and WABA If the rods, If the coatings and WABA rods, maybe we need to do some other kind of burn absorber. There's other options out there to ensure that the various peaking factor limits will be met.

CHAIR MARCH-LEUBA: But you do have to have a game plan. This is not going to be a one or two-month effort.

MR. JOYCE: Yes. Our folks in Westinghouse and our nuclear fuel group have done multiple studies looking at what it would take to go to, for example, two-year cycles to looking at the -- these have all been scoped out, again, scoping studies.

CHAIR MARCH-LEUBA: And they've been -- going to be recycled before you changed the --

MR. JOYCE: Yes.

MEMBER BALLINGER: Are we all set with your presentation? Are there any other questions from members or I got to be sure to make sure that the folks that are online also have a chance to chime in. Vesna, Greg, or Dennis, Bob?

MEMBER HALNON: No, I'm good. Thanks.

MEMBER DIMITRIJEVIC: I'm good, too.

MEMBER BALLINGER: Okay. We are actually scheduled for a break, but we're ahead of schedule. We're scheduled for a break at 2:30. Now I'm ambivalent.

MEMBER BIER: I'm guessing we probably need a break If the next step is closed session.

MEMBER BALLINGER: No, the next step is --

MEMBER BIER: Oh, okay. Sorry.

MEMBER BALLINGER: I'm just trying to guess how long people can survive If we just keep on going.

MR. JOYCE: The closed session was also contingent based on the questions asked right now, so I don't actually believe we have a need for the closed session based on the questions asked.

MEMBER BALLINGER: Okay. Why don't we be generous and take a -- what time is it? 2:01 to 2:15. Let's recess until 2:15.

(Whereupon, the above-entitled matter went off the record at 2:01 p.m. and resumed at 2:15 p.m.)

MEMBER BALLINGER: Okay. Now it's 2:16, and we're back in session. And the staff folks are up, and I'm not sure who is going to do what. Who's the presenter. Okay. So nobody that's sitting up-front. It's something over there that's doing the presenting. Okay.

MR. LAMB: Yes. My name is John Lamb. I work at the NRC's Division of Operating --

MEMBER BALLINGER: You're going to have to speak up or get closer to the microphone, yes.

MR. LAMB: Okay. Can you hear me now? My name is John Lamb. I work with the NRC's Division of Operating Reactor Licensing, DORL, in the Office of Nuclear Reactor Regulation, NRR. I will describe the licensing actions that SNC has requested. Charlie Peabody from the Nuclear Systems Performance Branch, SNSB, in the Division of Safety Systems, DSS and NRR, will discuss the Updated Final Safety Analysis Report, UFSAR, Chapter 15 Accident Analysis, the loss of coolant accident LOCA accident analyses and the non-LOCA accident analyses.

Brandon Wise from the Nuclear Methods and Fuel Analysis Branch, SFNB in DSS in NRR will discuss the code analysis, core physics and cladding. Kent Wood from SFNB in DSS in NRR will discuss fuel handling and storage. Joe Donoghue, the Director of DSS in NRR, will provide the conclusions.

SNC has requested four licensee actions. One is a license amendment request, and three are exemptions. The license amendment request is to revise the License Condition 2D and three technical specifications. The proposed change to License Condition 2D is to delete a 1986 exemption to Title 10 of the Code of Federal Regulations 10 CFR, Section 70.24, Criticality Accident Requirements, because SNC is voluntarily adopting 10 CFR 50.68, Criticality Accident Requirements.

Three technical specifications that SNC are proposing are to one tech spec, 3.7.18, Fuel Assembly Storage in the Fuel Storage Pool; two, tech spec 4.2.1, Fuel Assemblies; and, three, tech spec 4.3 Fuel Storage.

The first exemption is to 10 CFR 50.46, which is the acceptance criteria for emergency core cooling systems for light water nuclear power reactors. And the second exemption is 10 CFR Part 50 Appendix K, ECCS evaluations models. The proposed exemptions to 10 CFR 50.46 and 10 CFR Part 50 Appendix K would allow the use of coated AXIOM cladding with ADOPT fuel pellets enriched up to six weight percent

Uranium-235. ADOPT, AXIOM, PRIME, ZIRLO, and Optimized ZIRLO are registered trademarks of Westinghouse Electric Company, LLC. The third exemption is to 10 CFR 50.68(b)(7) to allow greater than five weight percent Uranium-235.

SNC plans to install four lead test assemblies, LTAs, with accident tolerant fuel, ATF, features in Vogtle Unit 2. The four ATF LTAs with ADOPT uranium dioxide fuel, AXIOM cladding, chromium coating, and four rods per LTA, 16 total rods with up to six weight percent enrichment Uranium-235.

SNC is not requesting a higher burn-up greater than its current licensing basis of 60,000 megawatt day per metric ton uranium. In the future, the NRC staff expects the licencee to request batch loads greater than five weight percent Uranium-235 enrichment and/or higher burnups.

Four LTAs that SNC is proposing to install in Vogtle Unit 2 is a Westinghouse 17 by 17 PRIME optimized fuel assembly design, and each contain up to 132 rods with Westinghouse ADOPT uranium dioxide pellets at maximum of five weight percent enrichment and coated AXIOM cladding; three rods with Westinghouse ADOPT uranium dioxide pellets at maximum of six weight percent enrichment and coated AXIOM cladding; one rod with Westinghouse ADOPT uranium dioxide pellets at a maximum of six weight percent enrichment and uncoated AXIOM cladding. All other rods will have uranium dioxide pellets at a maximum of five weight percent enrichment; zirconium bifluoride integral fuel burnable absorber, IFBA, coated pellets and coated AXIOM cladding.

Now I'm going to turn it over to Charlie Peabody to discuss the USFAR Chapter 15 accident analysis and the LOCA and non-LOCA accident analyses.

MR. PEABODY: Thanks, John. So as part of my review, I looked at the accident analysis. When I started with that, kind of the way that it was first broken down was to look at accidents that have core-wide effects and accidents that have local effects. So the accidents that deal with core-wide effects, as you can see on this slide, and I think Ryan mentioned it in the earlier presentation, 16 out of about 51,000 rods only actually drives up the total enrichment of the core by three ten-thousandths of a percent. So that was negligible and within the margins of the existing analyses of record.

Next slide, please, unless there are any questions. All right. Next slide.

Like I said, this increased enrichment is not a significant driver of increased source term dose consequences of cooling requirements and it's within the bounds of the existing safety analysis, which we use to establish the source term and dose consequences.

Next slide. For the LOCA analyses, the LTA parameters were put into the existing analyses and the containment response, again, are primarily impacted by initial pressure and temperature conditions, as well as the break locations. The difference in enrichment doesn't affect either of those, and that basically makes the analysis of record bounding and doesn't cause any changes for the downstream containment and compartment responses either. And the conclusion of both the large and small-break LOCA analysis was that 50.46 acceptance criteria for LOCAs continue to be met without any modifications to the codes.

The non-LOCA analyses, Westinghouse was able to perform an evaluation of some of the non-LOCA analyses. There's no impact to any of the computer codes, methodologies, or acceptance criteria. The LTA geometry material properties and reactivity feedback characteristics didn't have any substantive impact on the analyses, but they remain within the existing margins and the LTAs do not impact the departure from nuclear boiling ratio or the peak clad temperatures for an of the --

CHAIR MARCH-LEUBA: Let me interrupt you.

MR. PEABODY: Okay.

CHAIR MARCH-LEUBA: All these conclusions about the computer codes being applicable, are they restricted or limited only to this particular LTA application or is it for any six-percent enrichment?

MR. PEABODY: That's a very good question. I would agree with that. This is for this particular application that's before us, and it is largely limited because there are so few actual enriched rods. If the licensee was to propose a batch load, the licensing review that would go along with that would have to relook at all these again and I would expect to see more substantive changes.

CHAIR MARCH-LEUBA: To the codes themselves.

MR. PEABODY: Yes.

CHAIR MARCH-LEUBA: Based on what? I mean, six-percent enrichment doesn't feel like that much. I mean, there's a little change in the spectrum, there's a little change on this and that, but the fuel is still 94 percent U-238.

MR. PEABODY: I don't know. I don't really want to get too far into hypothetical license amendments. When I have an amendment and we're assigned to review it, then we'll kind of pass judgment on it.

CHAIR MARCH-LEUBA: These conclusions are exclusively for this particular application.

MR. PEABODY: Yes.

CHAIR MARCH-LEUBA: But in a future submittal, we can limit it to the preliminary work that we've done here, right?

MR. PEABODY: Yes. And that's my understanding is that that's part of, and I don't want to speak for the licensee in this regard, but I believe that the purpose of these LTAs are to gain more data to go towards a more, you know, broad applicability in the future.

CHAIR MARCH-LEUBA: I was planning to make this comment at the end of your presentation, but, since I interrupted you, maybe you an address it during the presentation. We've said it before, this is repeated, this is not ACRS comments. It's an individual member and off-the-cuff feeling, but aren't we overdoing this? For God sake, we just put in 16 pins in the core. In the real old times, we put 150 pins to see what happens. I'm not saying the licensee doesn't need to analyze and know exactly what happens in their core; they do. They're taking the risk putting it there. Are we even doing the review? Can any of the risk-informed concepts guide us to -- it feels like too much review effort for just 16 pins. And that may be above your pay grade.

MR. PEABODY: Well, again, I think it gets back to, again, we review the license amendment requests that are presented to us by the licensees. I think it was also brought up that there is a standard lead test assembly program which is in tech specs. In this case, the licensee felt that they needed to get the data from non-limiting locations, so they submitted it under this. And that's something that, you know, when you ask for that change, you know, we need to review the changes that are made to that. And If we didn't conclude that the risk was unacceptable, but I don't think this is necessarily submitted solely on a risk-informed or risk base. It just gets back to the fact that these quantities are within the licensing basis documents, and, If they need to be changed, it needs to be done under a 50.90 review.

CHAIR MARCH-LEUBA: Let me put in the

record an attaboy for one of your colleagues. We were reviewing a couple of weeks ago a topical report. He used risk-informed approaches to the review. He called it the risk template. You can ask yourself what can possibly go wrong, what is the consequences, and how probable that is. And based on that template, he made a perfect topical report that said what could go wrong is we misestimated thermal power by four and a half percent, the consequence is nothing, and the probability is 100 percent, but still it's nothing.

So you've got 16 pins. Maybe we need to start using risk -- I hate probabilistic risk assessment. I absolutely hate it. But there are some places where risk informed does make sense, and that will be the last time I say anything good about PRA. Just my opinion. You don't need to answer. It's way above your pay grade.

MEMBER BROWN: Can I ask you a question about why we're doing it. I totally agree with you. I hate PRA also, from that standpoint. You know that well after 15 years. But it seemed to me, from listening to both of them, they exceeded or violated or got outside the boundary of an exemption that was within the licensing basis, and it seems to me, If I was a regulator, put on another hold hat of not only being the designer but the regulator, as well, that they had to seek agreement that it was okay to exceed that exemption. I mean, that's what they pointed out, exceeding five weight percent for the U-235. So that's just an observation.

The other question I had, you said this was kind of trivial, which I agree with, 16 out of 51,000 pins or whatever, but then asked about what If you put them all in. And to me, that was 4.2 to 6 is more than 30 percent or 25 percent or something like that, and that seems to be a pretty big number. So I guess I'm, so in the few instances, I'm asking you a question, as opposed to you asking me.

CHAIR MARCH-LEUBA: Well, let's bypass the staff on this. If you ask yourself on the risk template what can possibly go wrong, the answer -- and then the second one is what are the consequences. Whether there's 16 pins or 100,000, it makes a big difference. But in this particular problem I would ask myself what could possibly go wrong If you put six-percent enriched uranium in the facility? Well, obviously, criticality comes to mind. What would be the consequences? Real bad. If you miss your criticality prediction, that's a bad consequence. And, therefore, we need to review criticality.

But what can possibly go wrong that the DMB limit is off by one percent because some power change or something like that? What are the consequences? Nothing. So we don't have to concentrate our effort on DMB review, we have to concentrate on criticality.

That type of argument, I'm just giving you --

MEMBER KIRCHNER: Usually, the criticality margins are even much bigger than DMB margin. Obviously, like in storage conditions, you're looking for a K less than 0.95. That's huge. So four pins are not going to have a big impact there.

But as I was suggesting earlier, depending where the four pins are in the bundle, you could actually exceed this last bullet in certain scenarios. So that's a factor, I assume, you all looked at that specifically, If they put the four pins by a control rod guide thimble, you get a nice peak out of that. And If you had a rod ejection, If it were in a control rod location, you'd get a nice bump out of your six percent when you did the analysis --

CHAIR MARCH-LEUBA: But they told us --

MEMBER KIRCHNER: -- not such an issue for things like --

CHAIR MARCH-LEUBA: And that's why they put the LTAs on an element. So I'm just thinking here it feels a little bit too much.

MEMBER BALLINGER: We're being a little bit tongue-in-cheek here, but the bottom line is, If we write a letter, it has to answer the question is there a safety issue, you know, and that's what we're after. So that's why some of these questions are answered. I mean, a 50.46 exemption, that's a routine thing because Zircaloy-4 is the last one that's in the rule. People have to, If they want to use M5, they got to get an exemption, right? So some of these things are administrative.

Anyway, I mostly agree with Jose, but, again, now it's two persons' opinion.

MEMBER KIRCHNER: But both parties have to do due diligence.

MEMBER BALLINGER: Yes, of course. Yes, yes. And that's what you're doing. That's what you're doing.

MEMBER SUNSERI: So this is Matt. I want to be on the record to say I embrace the use of risk-informed decision-making because it reminds us of some of our processes. But that's not my question. My question is you used some language on this slide and the previous slide. I'll just read the bullet: no impact to computer codes, methodology, or acceptance criteria. And I just want to make sure I understand what that statement is saying because the way I'm reading this is the enrichment is what's changed and you've looked at the computer codes and they can be used as-is and the methodology can be used as-is. And when I use those computer codes and the methodology with the enrichment that's being proposed, the acceptance criteria is still being met. Is that the way to read that statement, or are you intending something else with the way that's worded?

MR. PEABODY: Yes, that is the way to read that statement, but I would give the same caveat that your colleague just brought up that that's for this particular application and the fact that there is a very small overall increase in enrichment that keeps those codes and methodologies bounding. If you had a larger-scale change, you would have to look at that again.

MEMBER SUNSERI: Okay. Thank you.

MEMBER BALLINGER: Let's proceed on a less philosophical level here.

MR. PEABODY: The one localized accident which did have impacts was the control rod ejection event. Again, this was discussed in the last section, and we ultimately came in the amendment to specify that, while we are permitting certain non-limiting locations, they have to remain limiting with respect to the rod ejection analysis.

Next slide. This is where I turn it over to Brandon.

MR. WISE: Hi. I'm Brandon Wise with the Nuclear Methods and Fuel Analysis Branch, and I did the review for neutronics, core physics, thermal hydraulics, and fuel rod design.

For the neutronics portion of the review, SNC used the PARAGON lattice physics code for neutronics calculations. PARAGON itself is not approved for enrichments greater than five percent, but, because there are only 16 rods that are greater than five percent, it's not that big of an issue. We don't believe that there's some significant discontinuity after five percent in PARAGON code performance.

Furthermore, PARAGON2 is approved for enrichments greater than five percent, and it was approved partly based on code-to-code comparisons with PARAGON, which showed good agreement between PARAGON and PARAGON2. So that further justifies the use of

PARAGON for this specific application at enrichments greater than up to six percent.

CHAIR MARCH-LEUBA: I'm not familiar with Westinghouse method. What's the difference between PARAGON and PARAGON2 and why didn't they use PARAGON2?

MR. WISE: PARAGON2 is an updated code. I can't recall the exact specific --

CHAIR MARCH-LEUBA: Was it approved?

MR. WISE: PARAGON2 is approved. It's been reviewed and approved, and my next slide will go into, actually the second bullet point there has a line from the safety evaluation that PARAGON2 has been shown to be acceptable to analyze the neutronic performance of new and unapproved fuel designs, which we've extended that to apply to these LTAs and the characteristics of the LTA, such as ADOPT fuel. That's for PARAGON2 but not for PARAGON, of course, because of the code-to-code comparisons with PARAGON2, we've sort of extended it for this specific application.

MEMBER KIRCHNER: Usually, you don't do code-to-code within a code sweep or evolution. So I'm assuming somewhere PARAGON or PARAGON2 was benchmarked against NCMP or something else. Is that a correct assumption?

MR. WISE: It's not the sole justification for the approval of PARAGON2, and I think that's true for just about every code we approve that it can be part of it but it's not the sole reason we would approve a code.

DR. SCHULTZ: But, Brandon, is this just a timing issue here that it is that, when SNC did their evaluation, they used PARAGON and NEXUS? It seems like that was an earlier version of what PARAGON2 is.

MR. WISE: I'm not familiar with that. I just know that PARAGON and NEXUS are the license codes for SNC. And, lastly, that there's no proposed changes to the nuclear design process, so we don't believe there's any reason that PARAGON would be used out of its comfort range.

Next slide, please. For core physics, the FLEX spectrum will continue to be dominated by the co-resident fuel because of the limited number of LTAs and high-enriched rods. The peaking factors remain less than what is assumed in the FSAR. As was stated before, the higher-enriched rods in ADOPT fuel --

CHAIR MARCH-LEUBA: And that's used in the six-percent pins?

MR. WISE: Yes. There will be some

increased peaking factors, but those, at increase, is less than the assumptions in the FSAR. The differences between the LTAs and co-resident fuel are modeled explicitly, so the codes that are used to model these LTAs will capture any relevant phenomena. There may be some increases in uncertainty as you go beyond the approved range of applicability, but we don't believe that this will take the codes into areas where they're wildly uncertain. And, lastly, the neutronic impact of the LTAs is likely to be confined to the LTAs, such that they don't adversely affect the neighboring co-resident fuel.

Next slide, please. For thermal hydraulics, the codes and methods used by SNC are mostly unaffected by LTAs. The thermal hydraulic performance in general, the enrichment and ADOPT fuel pellets has very little effect on the thermal hydraulic performance. There's no changes to the related acceptance criteria, and there is no expected loss of margin for DMB. And the coated cladding, which might improve thermal hydraulic performance is not credited in the SNC analysis and is instead modeled as an increase in the outer diameter of the AXIOM cladding, which would result in negligible reduction in flow area. And, again, we don't believe this will have any significant impact on the thermal hydraulic analysis.

MEMBER KIRCHNER: So, Brandon, I find that last bullet interesting. This coating is microns, correct?

MR. WISE: Yes.

MEMBER KIRCHNER: Our thermal hydraulic codes aren't good enough to a change of thickness measured in microns first. Is there any significant change in the cladding thermal conductivity as a result of the cladding being coated?

MR. WISE: There will be slight differences in the thermal conductivity, but the coated cladding, it's thickness and the differences in the thermal conductivity would have little impact. And the choice for coated cladding is largely due to similarities with the zirconium or Zircaloy substrate.

MEMBER KIRCHNER: So, yes, I would just make an observation, it's not a question, that our models aren't that good to change the cladding thickness by microns and expect to see -- If you did see a big difference, I would want to know why because the subchannel analyses and the system codes aren't going to pick that up.

But going back to your physics law, it

would seem to me that the core physics actually, I wouldn't see a big change in uncertainty in core physics because you go to six percent because that part is well-modeled in the actual methods. I mean, the amount of U-235 that's in the fuel and the cross-sections are a count of that, so the uncertainty in the core physics models as you go to six percent is probably not significant.

MR. WISE: They probably decrease because the cross-sections associated with U-235 are more well understood.

DR. SCHULTZ: I was going to mention that you'll get both have gone over the wide range of enrichment.

CHAIR MARCH-LEUBA: If anything, I would be worried about additional burn-up, which are the hardest part to model. So If you are trying to overcompensated for the six percent by putting more of something else, then you still have the assumption but still minimal. It's going from five to six.

MEMBER KIRCHNER: So, Brandon, it's probably unfair to ask you this question, but I'll throw it anyway. I think it's good to ask unfair questions.

A lot of these limits that we have in the regulations are just arbitrary. Five percent, there's no technical reason why we couldn't go to six percent, other than it's outside the experiential basis that we currently have.

DR. SCHULTZ: It wasn't what was set before.

MEMBER KIRCHNER: Yes. But from the physics, the methods standpoint, five or six percent, it doesn't matter. The physics methods will work equally well. They don't realize there's a regulation that says only five somewhere. The methods are much more generic than that.

At some point, it's something for the staff to think about. We went through, you, not we, went through a review, 50.52, and the scope of that was limited just to reconcile and take into account lessons learned. But at some point perhaps, the staff can propose something with regard to the existing regulations that is more a technically sound basis for some of the limits that we see, such that the industry isn't coming back asking for exemptions. I mean, you wouldn't want, like you were saying, Charlie, for them to do an LAR for a specific change to the core, but the five-six percent of that is somewhat --

MR. PEABODY: So that's actually something that the staff is considering very thoroughly right now. One of my other tasks is I am on the increased enrichment rulemaking working group, so we're looking at and we're looking across all a bunch of different regulations. We're currently taking the regulatory basis based through concurrence, and I believe that we are going to be trying to get on your calendar shortly.

MEMBER BALLINGER: Joe Donoghue used to have his hand up.

MR. DONOGHUE: Charlie just nailed it. Thank you, Chair.

MR. MARKLEY: This is Mike Markley. I'm the chief of licensing for Vogtle. And just a little bit of history. As you know, 50.68 is a voluntary regulation. We were having lots of exemptions back when most plants, 70.24 was their licensing basis. And so the ones who chose to go with 50.68 as their licencing basis, we weren't doing exemptions for all those small changes in enrichment under five percent. And so that was, it went through a rulemaking, and it was because, If you have this many exemptions for a particular regulation, there's probably something wrong and you might need to fix it. And that's what 50.68 was.

And back on the other piece of this, had they chosen to, for example, put them in non-limiting locations that's one less amendment we would have had because they would have met that tech spec without any request.

MR. WISE: Okay. Now I'll go through each of the characteristics in the LTA, starting with the AXIOM cladding. The topical report was approved in December 2022, which was a few months after the submittal of this application, so it was not adopted by the licensee in their tech specs for their license. However, the staff did use the topical report and the associated conclusions to better inform our safety determination.

Use of AXIOM cladding does require an exemption from the applicability requirements in 50.46 and Appendix A. This is consistent with Optimized Zirloy, and there's lots of precedent for this.

Next slide, please.

DR. SCHULTZ: Brandon, before you leave that, the question that's not pertaining to that slide particularly but rather AXIOM cladding. I just noticed that in all, because you probably did this modeling, in all the four LTAs, there's only one rod that is not coated with AXIOM. It's an uncoated rod.

Do you know what the rationale is for having one rod or assemblies that is uncoated? Is there something we're going to learn from one six-percent rod that's not coated?

MR. WISE: Maybe someone can correct me If I'm wrong, but I believe they're all AXIOM and only one of them is uncoated with chromium.

DR. SCHULTZ: Yes, that's what I meant. Yes.

MR. WISE: I don't have the specific rationale. That would be a question better suited for SNC. But I imagine it would be to compare the performance between coated and uncoated AXIOM.

DR. SCHULTZ: A few more rods in that same category would have helped, but we'll see what happens for that rod.

MR. WISE: AXIOM cladding is a zirconium alloy which is demonstrated better in reactor performance than Optimized Zirloy. For the purposes of this review, we assumed that AXIOM performs at least as well as Optimized Zirloy, so there's no reduction in performance or loss of safety margin compared to the co-resident fuel which does use Optimized Zirloy. Therefore, the NRC staff determined the use of AXIOM cladding in these LTAs is acceptable because there are no expected loss of safety margin or reduction in any acceptance criteria because the same acceptance criteria from 50.46 are used.

Next slide, please. Most fuel rods or, rather, all but one fuel rod will have a thin chromium coating for increased corrosion resistance, and this is not credited in the analyses. It's instead modeled as a small increase to the outer diameter of the AXIOM cladding.

Next slide, please. Overall, we concluded that there's no expected loss of safety margin associated with the chromium coating. However, there is one phenomena that is detailed in the ATF Interim Staff Guidance 2020-01 which states that reduced cladding emissivity is a potential adverse effect on the chromium coating. This is because the chromium coating has enhanced corrosion resistance; and, therefore, it has a shinier surface which results in a lower emissivity, which corresponds to a higher peak cladding temperature when radiative heat transfer is the primary means of heat transfer, such as in a LOCA.

SNC's analyses indicate that during LOCA conditions the difference in emissivity between the coated and uncoated cladding has little effect on PCT. This was resolved during a supplement when we inquired further about the specific phenomena.

Four rods in each LTA will be enriched to a maximum of six weight percent of U-235. There's some codes and methods that were approved or have data in this range of extended enrichment. It's fairly common for some codes to be approved up to five percent but have data and bench marking well beyond that, and so that was the justification for why some of the codes and methods were applicable to these higher-enriched rods. And also the biggest part of the justification is the fact that there's only 16 of them in a core of 50-something thousand.

Overall, the neutronic impact of the LTA is expected to be small and confined to the LTAs. There's no adverse effects on the co-resident fuel.

And, lastly, ADOPT fuel pellets. The topical report was approved on June 2022, which was about two weeks before the application was submitted. So some of the finer details of that were not addressed in the application, specifically this one limitation and condition in the SE that licensees must demonstrate that control rod ejection models, methods, and acceptance criteria must be demonstrated to be applicable to fuel designs containing ADOPT fuel pellets. While it's not explicitly addressed in the application, SNC does state that the LTAs will not be placed in positions that are limiting with respect to control rod ejection, and this was enough for us to say that this limitation condition would have been satisfied should they have adopted the topical report. Technically, it's not necessarily for them to address this, but we did use the topical report and its conclusions to inform our safety determination, and we felt that this specific limitation and condition was significant.

Next slide, please. ADOPT fuel pellets contain a small amount of chromia and alumina, which result in a higher density than standard UO2 pellets. Therefore, these ADOPT fuel pellets have a greater quantity of fissile material and may be more sensitive to reactivity-initiated accidents, which is why that limitation and condition regarding fuel rod ejection models exists.

And as I stated earlier, SNC has stated these LTAs will not be placed in positions that are limiting with respect to rod ejection accidents, which means that they won't be placed in rodded locations.

CHAIR MARCH-LEUBA: But, Brandon, thinking the long game, eventually, we're going to have to go a third of the core in there. How do you envision this limitation to be resolved?

MR. WISE: The licensee will have to provide some analysis that demonstrates that its control rod ejection models, the models that they use perform adequately for ADOPT fuel pellets. I believe there's some more specific language included in the topical report for ADOPT fuel that I cannot recall right now.

CHAIR MARCH-LEUBA: I'm not sure, I'm pretty sure there's an experiment out there that has some increased enrichment, but the random ramp experiments with chromium dope ramps, power ramps, we'll have to make a plan of what will be sufficient to satisfy.

MR. WISE: And that will be a significant part of the review when batch loads of ADOPT fuel come in.

CHAIR MARCH-LEUBA: From the point of view of the licensee, I mean, whenever you have a guide, a regulatory guide or an SRP, it's easier to satisfy it If you know what questions the staff is going to ask me. If you are playing the game, it creates a lot of regulatory uncertainty. I mean, it would be nice to think from the point of view of the regulator what -- I'm not asking you to write a regulatory guide but think what would be sufficient.

MR. WISE: And the reg guide for control rod ejection would play a big role in determining whether or not the model is applicable to ADOPT fuel, and that justification for why that reg guide would be applicable would come with the application.

Next slide, please.

MR. SMITH: Before you move on, I apologize, this is Jim, Westinghouse. I wanted to get a clarification relative to the last sub-bullet on this slide. Radu, can you provide that clarification?

MR. POMIRLEANU: Yes. It was stated earlier that not being limiting with respect to rod ejection accident, the LTA will not be placed in a rodded location. While this is indeed achieving that, it is not necessary that the LTA not be placed in a rodded location. What we meant by not limiting in the rod ejection accident means that the LTAs are less limiting than the co-resident fuel in a rod ejection accident. There are rodded locations and there are rodded locations in the core. Some of them are more susceptible to higher exertions or, you know, their neighbors may be susceptible to higher exertions, depending on whether a fresh fuel or burned fuel.

So what was meant in the LAR was just,

like I said, the LTA are less limiting than the co-resident fuel, not that the LTAs will not be placed in a rodded location.

CHAIR MARCH-LEUBA: This is Jose. I thought the question we were talking with Brandon about is the applicability of your methods to analyze, to reach the conclusion that you just mentioned. Is the method applicable to this LTA, and the staff has to agree with that, right? We're not questioning the result. The result is obvious. As long as it's not limiting, no matter what it is, it's good. The question is is the method appropriate to calculate that conclusion?

MR. WISE: I'll elaborate a bit more on the justification used to reach that conclusion. Because the LTAs are not in positions that are limiting with respect to control rod ejection, they're distant from the limiting position, and so they essentially are viewed from the perspective of the limiting position as co-resident fuel because the differences are actually quite minor. And so the LTA characteristics almost become invisible at that point.

And so the control rod ejection model itself is not shown to be adequate for ADOPT fuel for this application. It's shown that the LTA does not affect the control rod ejection model.

CHAIR MARCH-LEUBA: Let me clarify. I mean, the method is not shown to be applicable. It was not attempted to be verified. We didn't try to verify the method. It's not that we tried to do it and failed.

MR. WISE: Right. We determined that it wasn't really necessary to go any farther than what was shown on this slide. Because it's not being placed in a limiting location, there's no further justification needed and no further clarification needed to satisfy the limitation condition.

Next slide, please. And now I'll hand the presentation over to Kent Wood to discuss fuel handling.

MR. WOOD: Thanks, Brandon. Now we get to the fun part. So SNC changed their licensing basis from an exemption to 70.24 to 50.68. 50.68, Paragraph B7, says you have a maximum enrichment of five weight percent of Uranium-235 and they want to go up above that for a couple of rods, 16 rods total, for each of the four LTA fuel assemblies.

Next slide. So these four rods, criticality is a localized effect, not a core-wide effect or a pool-wide effect. So we look on an assembly-wide basis, and they're still not adding a lot. You know, it's 0.015 percent more fissile material to a fuel assembly with those four rods in a standard analysis basis of five weight percent. That's like a third of the U-235 enrichment manufacturing uncertainty of 0.05 percent.

Next slide, please. What's really addingmore fissile material is the higher theoretical density of the ADOPT pellets. This slide says that, you know, I'll get down to the bottom, its lifeline's a little different. So the question we're adding here, like, the theoretical density, this the theoretical density. It adds, you know, 1.85, like those numbers are all accurate out to the third decimal place, right? You're adding more to the LTAs. That's okay. I can work with that. You know, you just consider everything being on one slide, you put everything on five slides so people can read it. Makes sense.

So the theoretical density, like we saw, is adding much more actual fissile material to the fuel assemblies in the enrichment, in the higher-enrichment rods. I mean, it's a minimal effect from the enrichment rods themselves.

Next slide, please. This is all leading

up to this. Here's the total amount of fissile material that's being added with respect to the new fuel storage vault, and the spent fuel pool analysis of records is, you know, 1.2 percent and 0.4 percent respectively. I bring these numbers up because, you know, our risk informed people use this to how deep do we need to dive into the criticality analysis compared to what we've got. So this is relatively minor increases in the amount of fissile material.

Next slide, please.

MEMBER BALLINGER: So let me make sure I understand this. The ADOPT fuel is approved?

MR. WOOD: Yes.

MEMBER BALLINGER: So they're going to stick that fuel in the spent fuel pool presumably --

MR. WOOD: Yes.

MEMBER BALLINGER: And it's got that theoretical density.

MR. WOOD: Yes.

MEMBER BALLINGER: And the increase in enrichment to less than six percent is less by a substantial amount than the increase in enrichment that occurred when they went from regular pellets to ADOPT?

MR. WOOD: Now, see, when they go to

ADOPT, they don't increase the enrichment. They just increase the theoretical density.

MEMBER BALLINGER: Density. I'm sorry. The increase in density, so the fissile density. Yes, the U-235 loading was increased by one point something percent.

MR. WOOD: Yes, much more than the enrichment.

MEMBER BALLINGER: Yes, much more than the enrichment, so why are we having this conversation?

MR. WOOD: Because they submitted the license -- because they need the exemption to 50.68, and we have to do our due diligence, right? And so that's why we're here, you know. And we're trying to do this as simply, as easily, and effectively as possible, and that's why I'm bringing this up to say, like, okay, so how much is this, how much margin do I need, because when they did these, you know, like, they did calculations, they did engineering judgment. They didn't actually go into these and do what would be termed a normal 95-95 type of calculation. They did some calculations, got some margin. These margins are huge; that's good enough, and that's what we're going on. And so I'm using this to say the actual increase in fissile material is small, and that hopes substantiate the idea of accepting those larger margins as being enough to cover these small increases.

Can I get the next slide, please. Okay. So the nuclear storage racks, the exemption they're crediting the IFBA in the LTAs where the licensing basis does not. The LTA, you know, like, the IFBAs, which is the installed poison, you know, provides a lot of hold-down margin, provides enough adequate. Like I got down here, it's 12,000 pcm, 0.12 delta k. I can never talk about these things in dollar amounts; that never made any sense to me. But, you know, you got huge margins here on, like, crediting the IFBAs and the new fuel storage vaults for a relatively small increase in change in fissile material.

Can I get the next slide, please. All right. So we believe with that large margin, that, you know, we're going to meet 50.68, Paragraphs B2 and B3. B2 is fully flooded, B3 is the optimum moderation.

Next slide. Spent fuel pool racks. So they're limiting their exemptions to two storage configurations, overall much more than two. The two out of four storage configurations was mentioned before. That's your standard checkerboard, alternating fresh unpoisoned, unburned fuel with empty cell. So that's what you're checkerboarding, alternating back and forth, like your standard checkerboard. And that's what it looks like.

CHAIR MARCH-LEUBA: And there's spent fuel pool --

MR. WOOD: Okay. Here we go. So this is a repeating two-by-two array. That's what makes it look like your standard checkerboard. All right. Next slide, please. This is the all-cell. The all-cell configuration is where it's a repeating two-by-two array where every storage cell is assumed to have a fuel assembly of equivalent reactivity, and so that would mean there's two-by-two arrays, you know, all four of those arrangements would have a fuel assembly in them, and there's a burn-up enrichment loading curve, you know, depending on how much your initial enrichment, how much burn-up is required to give you this equivalent reactivity. And these are repeated in the model with periodic boundary conditions, so it's an intimate repeating array.

They're not allowing any other storage in any other Unit 2 spent fuel pool storage configurations, which there are several. And there's no storage in Unit 1 allowed at all.

So two out of four exemption credits, the IFBA, and the LTAs, whereas the spent fuel pool does not, so this gets us similar to the new fuel storage facts. Two out of four, so, it's the numbers here. You know, so they're looking here at about 15,000 pcm of margin is what they've calculated. The last bullet there, they said that margin won't be challenged and it will decrease, but it will never be like it's a fresh fuel assembly. So that's the reason why I put it there. You know, it's one of those things that we look at it, we accept it, and we move on to the next slide.

Four out of four configuration. This exemption requires burn-up in the LTAs. The analysis of record burn-up is about 4 GWd, you know, for a fresh fuel assembly. It's actually about 39.5 GWd for a fresh five-percent enriched fuel assembly, and they put in a limit of 64 GWd, you know, which proves a lot of margin.

So how do you come up with 64? Is that enough margin? Probably.

Next slide, please. So I went in and I looked at that their analysis of record, and their analysis of record has a third order polynomial for calculating the enrichment loading curve. So they can calculate how much is required at zero, you know, like a zero burn-up, two, three, four, five percent, and then they fit it with a loading curve. And in this case, there's a third order polynomial and there's analysis of record. So I just extrapolated five percent out to six percent, and it said it would need about 53 GWd. You know, that's not exactly, that was certainly not the 95-95 number. But that would represent a fuel assembly where all of the fuel rods were at six percent, not just four.

CHAIR MARCH-LEUBA: You're kind of --

MR. WOOD: Okay. Going too fast?

CHAIR MARCH-LEUBA: No. I mean, I asked the question earlier, an hour ago, about this thing, so are we requiring them to be able to unload fuel from the core, it needs to be sufficiently burned so it fits in the suppression pool? I mean, If you don't have it at 53, you can't put it there?

MR. WOOD: Well, their requirement is 64.

CHAIR MARCH-LEUBA: I know.

MR. WOOD: So they're not going to be able to put it in the pool because they'll never get to 64 at this point.

CHAIR MARCH-LEUBA: So is --

MR. WOOD: Back up a slide, please. Back

up a slide until we get to the two out of four. All right. So this two out of four is fresh fuel, and they can store it like fresh fuel If they want to forever because there's no burn-up requirements for them to store it in that checkerboard arrangement.

CHAIR MARCH-LEUBA: Do we have enough suppression spent fuel pool capacity?

MR. WOOD: That's their question.

CHAIR MARCH-LEUBA: Well, I mean, you can elect that they are.

MR. WOOD: Well, it's a business decision on their part, not a technical decision.

CHAIR MARCH-LEUBA: No. I mean, If we approve on LAR, we're saying they can do it.

MR. WOOD: We're saying that it will meet the regulations If they do it. If they run out of storage space, I mean --

CHAIR MARCH-LEUBA: If you allow them to load the fuel into the core, you have to be able to take it out. Something happens.

MR. WOOD: And they can store it like fresh fuel.

CHAIR MARCH-LEUBA: Correct. But my question is can they do it? Do they have enough space?

MR. WOOD: That's their business decision to maintain full core offload capability If they need to. There's no requirement to maintain full core offload capability.

MEMBER KIRCHNER: If you're shut down, the you're shut down.

MR. WOOD: I mean, you just leave it in the pool, you just leave it in the core. I mean --

MEMBER KIRCHNER: They're not going to do that, Jose, for business reasons.

MR. WOOD: I mean, I hear what you're saying, but, you know, If they have a means to store that fuel safely in the pool. Now, licensees manage their spent -- this is off-topic really. Licensees manage their spent fuel pool inventory or what's in there with cask campaigns and whatnot, and they do it to their whatever fits in with their business sense, you know, their business plan. And sometimes they may or may not have, they may not have full core offload capability at any given, you know, like all the time, 24/7/365. There may be some time when they don't. There's no regulation that requires them to have it. Now, it makes good business sense to have it most of the time, but, you know, they can run into financial risk to not have it, but that's not a regulation. But they could store it in the two out of four fresh fuel checkerboard indefinitely.

CHAIR MARCH-LEUBA: This is a moot issue for what we're talking about today, which is the four LTAs. Obviously, four LTAs will fit anywhere. But in the longer term, it would be nice to at least know the answer.

MR. WOOD: Well, I mean, you'd have to ask them. This is an issue for them whether they have these LTAs or not. I mean, If they have to shut down, you know, like mid-cycle after they reloaded the core, do they have enough space to store those fuel assemblies. That's the reason they have more than these two storage configurations they're allowed to use, and managing the spent fuel pool real estate, you know, is an art. And I've got guys that probably do that full-time at each site.

CHAIR MARCH-LEUBA: They're never going to reach 64 GWd in the next few years.

MR. WOOD: No, not in the next few years. They said they'll probably have to come for another amendment. So why did they come up with 64? Because they thought it has enough margin that we don't really have to go into a precise detailed criticality analysis that If they were going to go and say, okay, I need exactly this much burn-up and no more, you know, If they were going to go into a -- that's why I was saying before, they came up and they've done analysis and they've applied engineering judgment to say, all right, this is what I think I'm going to need, I'm going to increase that margin so it gets through the regulatory analysis without having to do, you know, spending hundreds of hours on a safety analysis when you've got a ton of margin. And so that's a risk-informed way to do things. I mean, why go and spend that when you don't need it?

CHAIR MARCH-LEUBA: I'm not saying no. In fact, I was suggesting --

MR. WOOD: So there's always a question of whether or not, it's the standard comes up, basically, is whether licensees have full core offload capability. They usually do, you know, like, in any given moment, they may not as it goes through their cask loading plan, but I don't know what there are at any given time at any given licensee because it changes all the time.

So can we get back up to -- I think I'm almost done. Well, it might be 35 up there. So right here. So what I'm saying here is I went and I looked at their analysis of record, you know, in using their third order polynomial on their analysis of record, a six percent weight fuel assembly where all the control rods were six percent would require somewhere in the order of about 53 GWd. They put in a 64 GWd burn-up limit, so, to me, that 64 provides tons of margin and we can move on to the next question.

Next slide, please. So then it comes down to the accident, and the accident that they've analyzed, which is a multiple misloading event, they co-located the unburned LTAs as the limiting accident. You know, multiple misloadings of fresh unpoisoned and, like, unburned fuel assemblies is typically the limiting accident for the spent fuel pool.

The accident they estimated, they calculate the LTAs would be less than 0.95 with the tech spec cyber born of 2,000. In my initial read of that, I do not think that that analysis provided sufficient margin to go without, to preclude the detailed analysis that we would normally see.

So can I get the next slide? But that did not include the credit for ht IFBA, which are going to be there. So taking into account that the IFBA are going to be there in that two out of four loading configuration, I believe that they provide sufficient margin for that misloading accident to preclude the need for a more detailed analysis.

Next slide. All right. So here are my conclusions. The exemption request contains substantial margin for the two out of four and four out of four storage configurations. When IFBA is considered in a multiple misloading accident, there's considerable margin. Therefore, we believe there is reasonable assurance that 10 CFR 50.68(b)(4), which is the pool paragraph, will be met.

Next slide, please. So I will conclude myself again. This is Mike's? Okay. Sorry.

MR. MARKLEY: Well, it was actually Joe's, but I'm filling in for Joe right now. Mike Markley. The NRC has determined that reasonable assurance of public health and safety will be assured by installing these LTAs in Vogtle Unit 2 for up to two cycles, and we welcome a letter report. We would like some feedback on what you'd like to hear about a full ACRS meeting on the 14th. We've summarized the licensing actions. We feel like you probably want to hear more about technical areas, and we'd like to satisfy whatever questions that you have.

I'd just like to make one more comment. I worked as a senior staff engineer here from 1995 to 2001 with Dr. Apostolakis, so I'm an advocate for risk informed, as well. But, you know, we process the licensing actions that we have, and that's what we have as a regular deterministic action. Thank you.

MEMBER BALLINGER: Are we finished with the presentations?

MR. MARKLEY: Yes, we're finished, unless there is any other questions.

MEMBER BALLINGER: That's what I was going to say, If there was any. So are there questions from the members before we go out for public comment? I don't think we're going to need a closed session, unless some member has a question that requires that. But are there other questions from the members? We'll have another one of these question things after.

Okay. We haven't had any additional questions. We'd like to go out for public comment. If there are members of the public that would like to make a comment, please state your name and make your comment. I violated the 15-second rule, the 5-second rule.

Okay. Hearing no further comments, I'd like to thank you, as well as the applicant, for the presentation. What we'd like to do now is to have a discussion related to a letter or no letter, number one; and, number two, If it's a letter of some kind, what would members like to see in that letter?

I mean, I have my own personal opinion. My personal opinion is that we do a letter. My reasoning is that this is the first such application of an LTA with all of these designs in them and the long game, which is being played here because, eventually, there will be a batch load analysis that will have to be done and what's been happening here is, with the LTAs, it will be a very significant basis for that.

So that's my rationale, but I'm just one member. And also, no matter what, we have most of the members here, but in the full committee they are the ones that make the decision on whether we have a letter. We can make a recommendation, but, ultimately, it's the call for the full committee.

So with that being said, what are members' opinions?

MEMBER BROWN: I agree. I agree with you.

MEMBER BALLINGER: Okay.

MEMBER BROWN: That's one.

MEMBER BALLINGER: I'm sure that the emails will go back and forth, we always have that, and I'll say, well, why didn't you say something at the committee meeting? I don't know, I just, I'm saying it now, this kind of thing. But I'd like to have input from members related to the content of the letter because that would give you some information and the applicant for feedback because, If we do a letter, we'll have to do a presentation at the full committee and that will be a much shorter presentation, and so we'll have to stick to what's really important in that respect.

So questions or comments from members? Still none.

CHAIR MARCH-LEUBA: Okay. I'll volunteer.

MEMBER BALLINGER: We need a straight man for this thing.

CHAIR MARCH-LEUBA: I think a letter is warranted simply because of the first-of-a-kind application and, more specifically, increased enrichment. Even though we all agree just four pins won't make a difference, it's still a first-of-a-kind six-percent enrichment, so we need to have an opinion.

With respect to content, most likely we'll wait until you provide something and we'll --

MEMBER BALLINGER: That's what I meant. Okay. That's the way it works.

MEMBER REMPE: And the staff is pretty close to saying please write us a letter at the beginning of this discussion. Yes, they really --

MEMBER BALLINGER: Most of the slides, in the end, there was this is a no, never mind.

MEMBER REMPE: But Joe's opening remarks were very much saying please.

MEMBER BALLINGER: Oh, yes, yes, yes. But it's not his call whether they get a letter or not.

MEMBER REMPE: Well, usually, traditionally, If the staff says we would like a letter, we accommodate.

MEMBER BALLINGER: Yes, yes.

MEMBER SUNSERI: I would think, from the content of the letter, that I would think we would be remiss If we try to duplicate all of this discussion and everything. It should be a very short letter, very to the point letter, maybe emphasizing the opportunity to emphasize risk-informed techniques to cut down on the scope of the review or something of that nature. I don't know, but we already got two big in-depth presentations, and it would seem just a waste of effort to do it a third time for our review.

MEMBER BROWN: I agree with Matt. He's got a good point. There's some specific points that were made in the beginning relative to exemptions that they had to process. You lay that out, you lay out how they addressed it, and then the effort, the effect was very negligible and don't go through all the rest of the -- I don't think we said anything substantial within our discussions that should be put in the letter per se because they don't add anything to the end result.

MEMBER BALLINGER: Again, in effect, this is the culmination of a bunch of things that have happened, the cladding reports, all the approved documents that have built, they're being used here for this. And so this is a short letter but a lot of references.

MEMBER SUNSERI: I'll just say it maybe differently. Our job is to comment on the safety aspect of this application, which are virtually zero.

MEMBER BALLINGER: That's right.

CHAIR MARCH-LEUBA: The staff is dying to provide some comments.

MR. MARKLEY: This is Mike Markley again. So we recognize that your comments on this particular licensing action, set of actions, is maybe limited, but we really are hoping for anything that you might be able to forward, the batch loading which is one of the --

MEMBER BALLINGER: I'm not hearing you.

I'm sorry.

MR. MARKLEY: Oh, my apology. So we understand that the comments you may have on this particular set of licensing actions may be somewhat limited because of the risk that's inherent, but we are looking toward what insights you may be able to share with us or foreshadow that we may need to focus on more in the technical reviews for batch loading as they're coming toward us in the future. That's really the goal.

MEMBER BALLINGER: Yes, that's a good comment.

CHAIR MARCH-LEUBA: On that light, my initial comment of we leverage this for legal LTA's, once we call for review.

MEMBER BALLINGER: And several of your comments related to that.

MEMBER BROWN: And I think throwing in Matt's thoughts relative to the risk, I call it engineering judgment in my neanderthal troglodyte old age. But the risk informed is the new word for engineering judgment with frills and bells and whistles on it, so I think you need to point out that judgment is being used and we agree with the judgment that's being made. I think that's a key element of going to the next step of whatever we have to do. Batch obviously has to have -- I'm not even a fuels guy, and even I could understand somewhat the difference between what we have here and going to the full batch operations. So I think we have to say something relative to that, but it's a stepping stone to being able to do that in a rational matter.

MEMBER BALLINGER: Last but not least, for sure, Steve or Dennis, I haven't heard anything from Dennis, but I'm assuming he's out there.

DR. BLEY: Yes, he's here, but this is a committee decision. But I certainly agree with the comments that we're approaching a new area here and it's important for the committee to state its position.

DR. SCHULTZ: I agree with the statements the committee has made, and I think that some of the thoughts expressed today, both by the staff and the application and the committee, do reflect on what is going to be needed as we move forward to a batch load application of some type. That can progress gradually. In terms of the licensing, it's got to address some of the issues that did come up in the discussions today.

MEMBER BALLINGER: Okay. Thanks. So,

again, last but not least-least, time. How much time?

CHAIR MARCH-LEUBA: I was going to jump into this. I was going to place a mission impossible task on the staff and Westinghouse and try to limit your presentation to the full committee to a half an hour. Imagine that you're making that presentation not to a bunch of college professors and engineers but that you're presenting it to my mother because that is a presentation for the benefit of the public. Explain in a clear, concise way what the issue is and why should I have confidence that you've resolved the problem. And If you can keep it to half an hour, don't do 45 minutes. It's difficult, but it will be worthwhile.

MEMBER BALLINGER: What he's saying is short enough but still to get your main points across.

MEMBER BROWN: I assume Westinghouse is going to present, as well, or is it just the staff?

MEMBER BALLINGER: I don't know. Southern is the applicant.

MEMBER BROWN: Well, yes, I'm sorry. I meant Southern Nuclear, whoever they want. I guess that's the best way to phrase it.

MEMBER BALLINGER: I mean, I think that's appropriate, both Southern and the staff. That's typically the way we do it.

Okay. If there are no other comments, thank you again for the detailed presentations, you and the applicant, as well. And this meeting is adjourned.

(Whereupon, the above-entitled matter went off the record at 3:26 p.m.)

NRC Staff Presentation
Accident Tolerant Fuel (ATF) Lead Test Assemblies (LTAs) Vogtle, Units 1 and 2

June 21, 2023

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

OPENING REMARKS

Joseph Donoghue, Director

Division of Safety Systems

Office of Nuclear Reactor Regulation

OPENING REMARKS - Continued

- NRC appreciates the opportunity to share these proposed changes with the ACRS.
- Member feedback is valuable.
- NRC does not require an ACRS letter-report to proceed but would greatly benefit from one.
- An ACRS letter report would inform expected future batch loading requests for higher enrichment and/or higher burnup.

PRESENTERS

- Licensing Actions
- Chapter 15 Accident Analysis, LOCA, & Non-LOCA
- Code Analysis, Core Physics, and Cladding
- Fuel Handling & Storage
- Conclusion

- John Lamb – DORL/NRR
- Charley Peabody – SNSB/DSS/NRR
- Brandon Wise – SFNB/DSS/NRR
- Kent Wood – SFNB
- Joseph Donoghue, Director DSS/NRR

LICENSING ACTIONS

- SNC requested:
  - Amendments to License Condition 2.D and TSs: (1) TS 3.7.18, “Fuel Assembly Storage in the Fuel Storage Pool,” (2) TS 4.2.1, “Fuel Assemblies,” and (3) TS 4.3, “Fuel Storage.”
  - Three Exemptions
    - 10 CFR 50.46 and 10 CFR part 50, Appendix K to allow the use of coated AXIOM cladding, with ADOPT fuel pellets enriched up to 6 weight-percent U-235.
    - 10 CFR 50.68(b)(7) to allow greater than 5 weight-percent U-235

LICENSING ACTIONS - Continued

- Load four Westinghouse LTAs with advanced ATF features:
  - Advanced Doped Pellet Technology (ADOPT) uranium dioxide (UO_2) fuel,
  - AXIOM cladding, chromium coating,
  - four rods per LTA with up to 6 weight-percent enrichment U-235.
- SNC is not requesting higher burn-up greater than its current licensing basis of 60,000 MWd/MTU.

LTA DESIGN

- The LTAs are Westinghouse 17 x 17 PRIME Optimized Fuel Assembly design and each contain:
  - Up to 132 rods with Westinghouse ADOPT UO_2 pellets at maximum of 5 weight-percent enrichment and coated AXIOM cladding,
  - 3 rods with Westinghouse ADOPT UO_2 pellets at maximum of 6 weight-percent enrichment and coated AXIOM cladding,
  - 1 rod with Westinghouse ADOPT UO_2 pellets at maximum of 6 weight-percent enrichment and uncoated AXIOM cladding,
  - All other rods will have UO_2 pellets at maximum of 5 weight-percent enrichment, ZrB_2 IFBA coated pellets and coated AXIOM cladding.

UFSAR CHAPTER 15 ACCIDENT ANALYSIS

- General Accident Analysis, Core Source Term, and Radiological Dose Consequences
  - Most accidents, as well as source term, dose consequences, and design transients see negligible changes from placing 16 higher enriched LTA fuel rods into a core of 50,952 active rods.
  - Avg enrichment of the core is only increased 0.0003% by 4 LTAs.
  - Avg core enrichment remains ~ 4.4 – 4.6%.

UFSAR CHAPTER 15 ACCIDENT ANALYSIS - Continued

– This increase in enrichment is not a significant driver of increased source term, dose consequences, or cooling requirements, and is within the bounding assumptions and safety margins of the existing analyses which conservatively assume 5.00% enrichment for establishing source term and dose consequences.

LOCA ACCIDENT ANALYSES

- LOCA & Steam Line Break Mass and Energy Releases
  - The containment response for these accidents is primarily impacted by RCS initial pressure and temperature conditions, as well as the break location and area parameters.
  - Since these parameters are unchanged by the LAR, the analyses of record remain bounding for both short and long-term responses.
  - Downstream containment and compartment responses are also not impacted.

LOCA ACCIDENT ANALYSES - Continued

- Large and Small Break LOCA Analyses
  - Large and Small Break LOCA Evaluation Model (EM) computer codes were re-evaluated with LTA data.
  - Both EMs demonstrated that 10 CFR 50.46 acceptance criteria for LOCAs continue to be met without any code modifications.

NON-LOCA ACCIDENT ANALYSES

Vendor (Westinghouse) evaluated Steam Line Breaks, Locked Rotor, Loss of RCS Flow, and Control Rod Ejection

- No impact to computer codes, methodology, or acceptance criteria.
- LTA geometry, material properties, and reactivity feedback characteristics have no substantive impacts on the analyses and remain within existing margins.
- LTAs do not impact the departure from nucleate boiling ratio (DNBR) or peak clad temperatures (PCT).

NON-LOCA ACCIDENT ANALYSES - Continued

Additional consideration for Control Rod Ejection event analysis

- Application and supplements designate that while LTAs may be placed in certain limiting core locations, the LTAs may only be utilized in such locations which are non-limiting with respect to the control rod ejection analysis.

Neutronics

- SNC uses the PARAGON lattice physics code and NEXUS for neutronics calculations.
  - There is no significant deviation in the neutron flux spectrum. Therefore, there is reasonable assurance that these codes will adequately model the LTAs.

- PARAGON and NEXUS have been compared to the PARAGON2 code, which has been shown to be acceptable at enrichments greater than 5 wt% U-235.
  - "PARAGON2 has been shown to be acceptable to analyze the neutronic performance of new, unapproved fuel designs, …"
- No proposed changes to the nuclear design process.

CORE PHYSICS

- Flux spectrum will continue to be dominated by co-resident fuel.
- Peaking factors remain less than what is assumed in the UFSAR.
- Differences between LTAs and co-resident fuel are modeled explicitly.
- Neutronic impact of the LTAs are confined to the LTAs

THERMAL HYDRAULICS

- The codes and methods used by SNC for thermal-hydraulic analyses are mostly unaffected by the LTAs.
- No changes to any thermal-hydraulic related acceptance criteria are proposed and there is no expected loss of margin.
- Coated cladding is modeled as an increase in the outer diameter of the AXIOM cladding. This results in a negligible reduction in flow area due to the thin coating thickness.

AXIOM CLADDING

- WCAP-18456-P/NP approved December 16, 2022

- AXIOM cladding requires an exemption from the applicability requirements of 10 CFR 50.46 and Appendix K.

AXIOM CLADDING - Continued

- AXIOM cladding is a zirconium alloy which has demonstrated better in-reactor performance compared to the Optimized ZIRLO alloy.
  - The NRC staff expects AXIOM cladding to perform at least as well as Optimized ZIRLO cladding, which is used in the co-resident fuel.

- The NRC staff determined that the use of AXIOM cladding in these LTAs is acceptable because there is no expected loss of safety margin or reduction in acceptance criteria.

CHROMIUM COATING

- Most fuel rods will have a thin chromium coating for increased corrosion resistance.
  - SNC does not credit the chromium coating in its analyses.

CHROMIUM COATING - Continued

- There is no expected loss of safety margin associated with the chromium coating.
  - ATF-ISG-2020-01 states the reduced cladding emissivity is a potential adverse effect of a chromium coated rod that could increase PCT.
  - SNC's analyses indicate that during LOCA conditions the difference in emissivity between coated and uncoated cladding has little effect on PCT.

HIGHER ENRICHMENT

- Four rods in each LTA will be enriched to a maximum of 6 weight-percent U-235.
- Most codes and methods where fuel enrichment is a significant parameter have either been approved for use or contain data and models for enrichments greater than 5 weight-percent U-235.
- The neutronic impact of the LTAs is expected to be small and confined to the LTA.

ADOPT FUEL PELLETS

- WCAP-18482-P/NP approved June 13, 2022
  - “Licensees must demonstrate that CRE models, methods, and acceptance criteria are applicable to fuel designs containing ADOPT fuel pellets…”

ADOPT FUEL PELLETS - Continued

- ADOPT fuel pellets contain small amounts of chromia and alumina and have higher density than standard UO_2 pellets.
  - ADOPT fuel pellets have a greater quantity of fissile material and may be more sensitive to reactivity-initiated accidents, such as a rod ejection accident (REA).
  - SNC has stated that the LTAs will not be placed in positions that limiting with respect to REAs.

FUEL HANDLING & STORAGE

- SNC needs an exemption to 10 CFR 50.68 Paragraph (b)(7) for the fuel rods enriched above a maximum of 5.0 weight-percent U-235
- Each LTA is limited to four rods at a maximum of 6.0 weight-percent U-235.

FUEL HANDLING & STORAGE-Continued

- Those four rods add ≈ 0.015% more U-235 to the fuel assemblies relative to the Vogtle New Fuel Storage Rack (NFSR) analysis of record (AOR) and Vogtle Spent Fuel Pool (SFP) AOR maximum enrichment of 5.0 weight-percent U-235.
- That is less than a third of the U-235 enrichment manufacturing uncertainty of 0.05%

FUEL HANDLING & STORAGE - Continued

- Higher Theoretical Density (TD) in the ADOPT pellets adds more U-235 to the fuel assemblies than the four fuel rods enriched to a maximum of 6 wt/%.
  - Vogtle NFSR AOR used 96% TD.
  - Vogtle SFP AOR used 97.5% TD.
  - ADOPT TD of 98.3% is limited to 136 rods per LTA. (≈ half)
  - Increased TD adds ≈ 1.185% more U-235 to LTAs relative to NFSR AOR and ≈ 0.412% more U-235 to LTAs relative to SFP AOR.

FUEL HANDLING & STORAGE - Continued

- The total increase in U-235 for the Vogtle NFSR and SFP relative to the AORs is 1.2% and 0.427% respectively.
  - The relative increase in U-235 content is determined to aid in evaluating the potential impact on reactivity in the NFSR and SFP.

FUEL HANDLING & STORAGE - Continued

- New Fuel Storage Racks
  - Exemption credits the IFBA in the LTAs whereas the Vogtle NFSR AOR does not.
  - SNC estimated the LTAs 128 IFBA rods at 1.5x Boron 10 loading provide substantial reactivity hold down relative to its current AOR for the NFSR
    - ≈ 0.12 Δkeff for fully flooded
    - ≈ 0.10 Δkeff for optimum moderation

FUEL HANDLING & STORAGE - Continued

- New Fuel Storage Racks - Continued
  - NRC staff reviewed the estimates and believes the substantial reactivity margin provided by the IFBA provides reasonable assurance 10 CFR 50.68 Paragraphs (b)(2) [NFSR fully flooded] and (b)(3) [NFSR optimum moderation] will be met.

FUEL HANDLING & STORAGE - Continued

- Spent Fuel Pool Storage Racks
  - Exemption limits SFP storage to two Unit 2 storage configurations
  - The two-out-of-four (2oo4) configuration,
    - a repeating 2x2 array of alternating fresh unburned and unpoisoned fuel assemblies with empty storage cells, and

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FUEL HANDLING & STORAGE - Continued

- Spent Fuel Pool Storage Racks - Continued
  - all-cell (4oo4) configuration,
    - a repeating 2x2 array with each storage cell filled with a fuel assembly meeting the specified burnup/enrichment requirements
  - No storage in any other Unit 2 storage configuration is allowed.
  - No storage in Unit 1 SFP is allowed.

FUEL HANDLING & STORAGE - Continued

- Two-out-of-four (2oo4) configuration
  - Exemption credits the IFBA in the LTAs whereas the Vogtle SFP AOR does not.
    - Similar to NFSR

FUEL HANDLING & STORAGE - Continued

- Two-out-of-four (2oo4) configuration - Continued
  - SNC estimated the LTAs 128 IFBA rods at 1.5x B10 loading provide substantial reactivity hold down relative to its current AOR for the SFP
    - ≈ 0.15 Δkeff
  - That margin will decrease but remain substantial relative to a fresh unpoisoned fuel assembly.
    - NUREG/CR-6760, *Study of the Effect of Integral Burnable Absorbers for PWR Burnup Credit"*

FUEL HANDLING & STORAGE - Continued

- Four-out-of-four (4oo4) configuration
  - Exemption credits burnup in the LTAs.
- The AOR burnup requirement is about 40 GWd/MTU and a 64 GWd/MTU LTA burnup limit provides a 24 GWd/MTU or greater than 8% in keff margin for the LTAs.
  - Slightly more than a 5 weight-percent fuel assembly would require.

FUEL HANDLING & STORAGE - Continued

- Four-out-of-four (4oo4) configuration - Continued
  - SNC set a requirement for the LTAs to have 64 GWd/MTU of burnup.
  - NRC staff used Vogtle's SFP AOR to estimate a fuel assembly with all fuel rods at 6 weight-percent would require ≈53 GWd/MTU.
  - SNC's burnup requirement provides substantial margin.

FUEL HANDLING & STORAGE - Continued

- SFP Accident
  - SNC determined a multiple miss loading event that collocated the unburned LTAs was the limiting accident.
    - Multiple misloadings are typically the limiting accident.
  - SNC estimated the collocated LTAs would be < 0.95 keff with the TS Soluble Boron requirement of 2000 ppm.
    - This estimate did not have substantial margin to preclude a detailed analysis.

FUEL HANDLING & STORAGE - Continued

- SFP Accident - Continued
  - The SNC estimate did not include credit for the IFBA.
  - The two-out-of-four (2oo4) evaluation showed the IFBA provides significant margin.

FUEL HANDLING & STORAGE - Continued

- SFP Conclusion
  - SNC exemption request contains substantial margin for the two-out-of-four and four-out-of-four storage configurations.
  - When the IFBA is considered in the multiple misloading accident there is considerable margin.
  - Therefore, the NRC staff believes there is reasonable assurance that 10 CFR 50.68 Paragraph (b)(4) will be met.

CONCLUSION

- The NRC staff determined that there is reasonable assurance that the health and safety of the public will not be endangered by allowing SNC the use of four ATF LTAs for up to two cycles operation in Vogtle, Unit 2.
- The NRC staff welcomes an ACRS letter report.

ITEMS FOR DISCUSSION AT ACRS FULL COMMITTEE

- July 14 – ACRS Full Committee Meeting
- Licensing Action – Amendment and Exemptions to 10 CFR 50.68(b)(7), 10 CFR 50.46, and 10 CFR Part 50, Appendix K
- Technical areas of emphasis requested by ACRS Subcommittee members

ACRONYMS

- ATF – Accident Tolerant Fuel
- LTAs – Lead Test Assemblies
- NRC – U.S. Nuclear Regulatory Commission
- ACRS – Advisory Committee on Reactor Safeguards
- SNC – Southern Nuclear Operating Company
- NRR – Office of Nuclear Reactor Regulation
- DSS – Division of Safety Systems
- DORL – Division of Operating Reactor Licensing
- SNSB – Nuclear Systems Performance Branch
- SFNB – Nuclear Methods & Fuel Analysis Branch

ACRONYMS - Continued

- TS – Technical Specification
- CFR – Code of Federal Regulations
- U-235 – Uranium 235
- UO2 – Uranium Dioxide
- MWd – Megawatt-Day
- MTU – Metric Ton Uranium
- ZrB_2 – Zirconium Diboride
- IFBA – Integral Fuel Burnable Absorber
- LOCA – Loss-of-Coolant Accident
- EM – Evaluation Model
- RCS – Reactor Coolant System
- DNBR – Departure from Nucleate Boiling Ratio

ACRONYMS - Continued

- PCT – Peak Cladding Temperature
- REA – Rod Ejection Accident
- TD – Theoretical Density
- NFSR – New Fuel Storage Rack
- SFP – Spent Fuel Pool
- AOR – Analysis of Record
- 2oo4 – Two out of Four Configuration
- 4oo4 – All-Cell Configuration
- B10 – Boron 10
- ppm – Parts Per Million

Southern Nuclear

Lead Test Assembly (LTA) License Amendment Request (LAR) ACRS Subcommittee Meeting

Ryan Joyce – SNC
June 21st, 2023

Agenda

- **Vogtle LTA Program Objective**

- **Topics of Interest**
  - Vogtle LTA LAR
  - LTA Evaluation Method and Approach
  - Cladding Exemption – 10 CFR 50.46 and 10 CFR 50 Appendix K
  - Enrichment Exemption – 10 CFR 50.68(b)
  - Technical Areas
- **Questions**

Vogtle LTA Program Objective

- Initial goals of program (within scope of proposed LAR):
  - Irradiate higher enriched fuel in a commercial reactor to generate data in support of future licensing applications
  - Obtain additional data for accident tolerant fuel (ATF) materials

- Future goal of program (outside scope of proposed LAR):
  - Support licensing applications for higher burnup fuels

- Four Westinghouse ATF LTAs with higher enrichment capable of higher burnup
  - Four rods in each LTA with enrichment up to 6 wt.% ^{235}U
  - **AXIOM**® high performance fuel rod cladding (WCAP-18546-P/NP-A)
  - **EnCore**® chromium coated cladding
  - **ADOPT**™ doped fuel material for non-IFBA (Integral Fuel Burnable Absorbers) rods (WCAP-18482-P/NP-A)
  - Standard (undoped) fuel material for IFBA rods

Topics of Interest

Vogtle LTA LAR– As Supplemented on Sept. 13, 2022 and May 5, 2023

- The license amendment requested the following changes:

  - TS 4.2.1, “Fuel Assemblies,“ will be changed to reflect the LTAs:
    - Placement in limiting core regions (except for control rod ejection transients)
    - Inclusion of advanced coated cladding with doped or standard fuel material, and
    - Having a maximum nominal ^{235}U enrichment of 6.0 wt.%

  - TS 3.7.18 “Fuel Assembly Storage in the Fuel Storage Pool,” and TS 4.3 “Fuel Storage” will be changed to reflect LTA:
    - Spent and new fuel storage restrictions
    - Allowance for maximum nominal ^{235}U enrichment of 6.0 wt.% in the New Fuel storage racks

Vogtle LTA LAR– As Supplemented on Sept. 13, 2022 and May 5, 2023 (cont'd)

- To support this amendment, SNC adopted 10 CFR 50.68 as opposed to the previous licensing basis based on §70.24 Exemption, resulting in:
  - A proposed change to the FOL for both units to remove discussion on §70.24 Exemption
  - An Exemption request to §50.68(b)(7) to allow an enrichment of >5 wt.% ^{235}U (both units)

- An Exemption request to §50.46 and Appendix K was also needed for the use of **AXIOM** cladding (unit 2 only)

Exemption Requests

- An exemption to §50.46 and §50 Appendix K was requested for use of **AXIOM** cladding
- A more restrictive embrittlement criterion was used in conjunction with the 17% maximum local oxidation criterion
  - **AXIOM** cladding topical presents the data in support of this application

Exemption Requests (cont'd)

- Licensing basis to change from §70.24 to §50.68
- Exemption is needed to §50.68(b)(7) to allow these LTAs to have greater than 5 wt.% ^{235}U rods
- Technical Justification:
  - Intent of rule (to preclude inadvertent criticality) being maintained
  - Administrative controls will be in place for temporary storage of LTAs in Traveller-B containers prior to LTA placement in their designated storage locations
  - Remaining §50.68(b) criticality requirements are unaffected and continue to be implemented
    - New Fuel Storage Vault
    - Spent Fuel Pool

Key Analytical Impacts of the LTAs

- LTAs will lead the core during portions of steady-state operation and during some transient conditions
  - Leading the core = highest linear heat generation rate
- The LTAs and co-resident fuel will be shown to continue to meet all Technical Specifications (TS) 2.1 Safety Limits, 3.1 Reactivity Control, and TS 3.2 Power Distribution Limit requirements
- LTAs will remain within core operating limits
- The analytical methods used to determine the core operating limits will be those previously reviewed and approved by the NRC (per TS 5.6.5)
- A separate LAR will be required to go above the licensed fuel rod burnup limit

Small and Large Break LOCAs

- The current models and correlations in the BASH evaluation model (EM) for LBLOCA and NOTRUMP EM for SBLOCA are acceptable to evaluate LTA features and operation.
- LBLOCA LTA evaluation:
  - Peak cladding temperatures (PCT) bounded by the current analysis of record
  - Maximum local oxidation and the core-wide oxidation (maximum hydrogen generation) meet acceptance criteria
- The SBLOCA analysis of record is representative of the LTAs.
- The presence of the LTAs will have negligible impact on the co-resident fuel for SBLOCA and LBLOCA.

Non-LOCA Transients

- No impact on AOR for transients dependent on core-average effects
  - Negligible impact of 4 LTAs on core-average heat transfer characteristics, decay heat, initial core stored energy
- For events dependent on local effects (SLB, Locked Rotor, Loss of Flow, RWSC, Rod Ejection)
  - No impact due to LTA on approved non-LOCA codes, methods, or relevant acceptance criteria
  - No impact due to LTA geometry, material properties or reactivity feedback characteristics to non-LOCA safety analyses
  - Rod ejection transient: LTAs are placed in non-limiting locations
  - Event-specific statepoints used as input to departure from nucleate boiling ratio (DNBR) calculations are not impacted by the LTAs
  - Fuel-specific criteria continue to be met (e.g. as applicable, minimum DNBR, percent of rods in DNB, peak clad temperature, peak fuel enthalpy)

Source Term and Dose Consequences

- Core Source Term Evaluation
  - Utilized ORIGEN-ARP to generate core inventories for the LTAs
  - Considered 4 higher enriched rods/assembly (total of 4 assemblies)
  - Varied enrichment 3 wt.% to 6 wt.% ^{235}U
  - Varied assembly burnup 50 GWd/MTU to 83.5 GWd/MTU
  - Varied peak rod power 50% to 125%
  - Results indicated inconsequential impact on core inventory

- Comparison with Ch. 15 Dose Consequence AORs
  - Comparison based on core wide cycle specific loading patterns

- Comparisons concluded the core source term used in the AORs is bounding for significant isotopes that contribute to dose, as a result there is no impact to the dose consequence analyses

- Bounding AOR core source term inventories will be confirmed per Reload Analysis on a cycle specific basis

Fuel Rod Design

- The latest fuel performance models, PAD5 (WCAP-17642-P-A, Revision 1), are used to evaluate the LTA features:
  - ADOPT fuel
  - AXIOM cladding
  - High enrichment
- NRC-approved models are used for ADOPT fuel (WCAP-18482-P-A) and AXIOM cladding (WCAP-18546-P-A)
  - Fuel performance impacts on the LTAs are explicitly modeled with PAD5
- No corrosion resistance is credited for the Cr-coated cladding
- Although PAD5 was only approved for enrichment up to 5 wt.% ^{235}U, it was developed and submitted based on measured data up to 13 wt.% ^{235}U
  - Acceptable for modeling high enriched rods in the LTAs

Core Physics

- Explicit or conservative modeling of LTA features
  - Chromium cladding coating
  - Doped pellets
- No change to reload analysis methods, or the currently approved neutronic methods (PARAGON, NEXUS qualification)
- No impact to neutronic modeling for fuel rods above 5 wt.% ^{235}U
  - Few rods per fuel assembly → neutron flux spectrum similar to currently operating core
  - Benchmark to PARAGON2 for pin power reconstruction and peaking factor uncertainties.
- Core monitoring with **BEACON**[TM] Core Monitoring System is unaffected
  - Ability to predict the core not affected by LTA features
  - Small number of rods above 5 wt.%, placed away from instrumentation

Thermal Hydraulic Design

- Use existing methodology for LTAs
- No negative impact to DNB performance due to either **ADOPT** pellets or **AXIOM** cladding
- No impact to analysis limits from higher enriched fuel rods
- DNB performance of the coated fuel rods is similar to that of uncoated fuel rods
- Potential mixed core penalty due to slight increase in coated rods' outer diameter offset by available DNBR margin

Criticality Analysis

- The LAR addresses the following regarding fuel storage criticality:
    - Increased enrichment
    - **ADOPT** pellets
    - Chromium coated **AXIOM** cladding
- Modern codes were applied to separately address
  - Storage not requiring burnup credit - direct reactivity analysis
    - New Fuel Storage Racks
    - SFP two-out-of-four storage pattern
- Storage requiring burnup credit – Comparative reactivity analysis for the “all-cell” storage pattern

Criticality Analysis

- Storage acceptability in the New Fuel Storage Racks and the two-out-of-four spent fuel pool storage pattern were determined via direct reactivity analysis.

- New Fuel Storage Rack and two-out-of-four results demonstrated significant margin to the storage limit including Dry, Fully Flooded and Optimum moderation conditions for the NFSRs.

- Both storage analyses credit IFBA, for which the details of the IFBA requirements will be confirmed during the reload process.

- Additionally, a multiple full pool misload event was evaluated with the TS soluble boron limit of 2000 ppm demonstrating acceptable results.

Criticality Analysis Continued: SFP all-cell storage

- The AOR Burnup limit is about 40 GWd/MTU
- A burnup limit of 64 GWd/MTU was selected for the LTAs.
- This is
  - greater than 24 GWd/MTU from the current burnup limit
  - or greater than 8% in k_{eff} margin.

Acronyms and Terms

- ACRS: Advisory Committee on Reactor Safeguards
- AOR: Analysis of Record
- ATF: Accident Tolerant Fuel
- CFR: Code of Federal Regulations
- DNB: Departure from Nucleate Boiling
- DNBR: Departure from Nucleate Boiling Ratio
- FOL: Facility Operating License
- GWd: Gigawatt Days
- IFBA: Integral Fuel Burnable Absorber
- LAR: License Amendment Request
- LBLOCA: Large LOCA
- LOCA: Loss of Coolant Accident
- LTA: Lead Test Assembly
- MTU: Metric Ton Uranium
- NRC: Nuclear Regulatory Commission
- PCT: Peak Clad Temperature
- SBLOCA: Small LOCA
- SLB: Steam Line Break
- RWSC: Rod Withdrawal from Subcritical
- SFP: Spent Fuel Pool
- SNC: Southern Nuclear Company
- TS: Technical Specification
- wt.%: weight percent

Questions/Discussion